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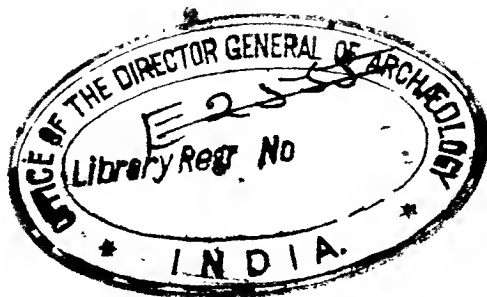
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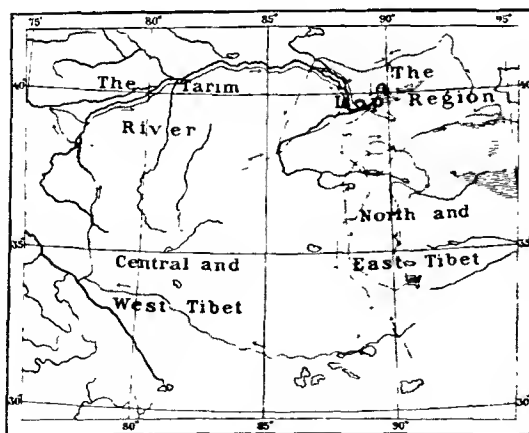
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VOL. I

THE TARIM RIVER

BY

DR SVEN HEDIN

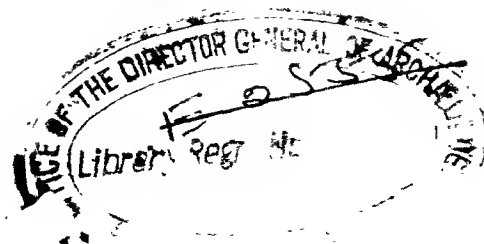


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# THE TARIM RIVER







Fig. 1. A SAND-DUNE EAST OF TEREM.

## CHAPTER I.

### FROM KASCHGAR TO THE JARKENT-DARJA.

The road which I traversed on 5—10th September 1899 between Kaschgar and Lajlik was already known to me in great part\* from my journey of 1895. But as it is shown on the atlas which accompanies this work, I may say a few words about it, especially as I have some new observations to add. These may be regarded as a sort of text to the first plate of the atlas.

I began my cartographical work immediately I got outside the Kum-därvase gate of Kaschgar. Thence we proceeded along the well-known road southwards, over the three bridges which cross the Kisil-su to Jangi-schahr. The river however now carried a very small quantity of water. Here about three o'clock a storm burst upon us which in violence exceeded anything I had conceived possible in the basin of the Tarim. For an hour and a half the rain literally came down in torrents, making the clay soil soft and slippery; while the thunder crashed deafeningly after every vivid flash. Shortly after leaving on the right the northern wall of Jangi-schahr, we found the road for several kilometers completely under water; in fact, the only guide we had as to where the track ran was the string of huts

---

\* From Kaschgar to Kan-arik I travelled over the same route on both occasions.



and gardens which stood beside it. After a while however the ground became drier, showing that the squall, which came from the north-west, had followed a well-defined course, and had not proceeded very far to the south-east; and the night which ensued was perfectly fine. Passing by the big *kischlak* or winter settlement of Natschuk, we encamped at the village of Musulman-natschuk, also known as Kalta-natschuk (Short Natschuk), a place of some 250 households.

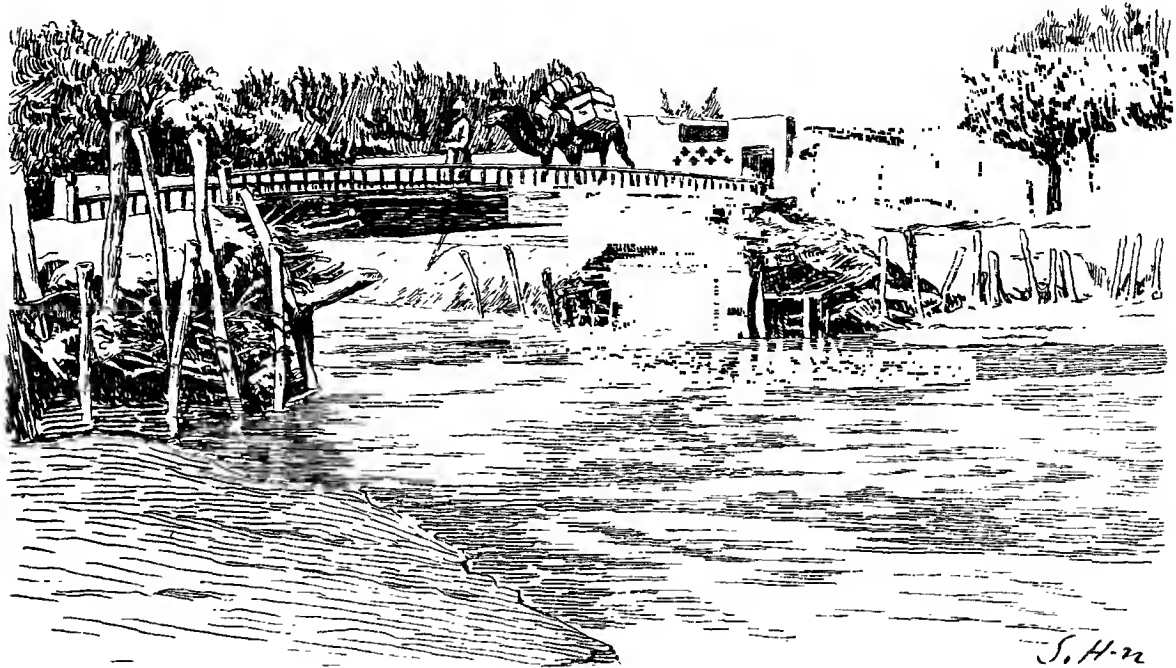


Fig. 2. THE BRIDGE AT JAJLAK.

During the whole of the following day both the Tien-schan and the Pamirs stood out with unusual clearness and precision. Owing to the recent rain, the atmosphere was remarkably pure and free from dust, so that the steel-blue flanks of the mountains, and their snow-white crests, wreathed in light fleecy clouds, came out with telling effect. Upon reaching Tschige-tugh, we struck an old river-bed, the course of which was defined with the utmost distinctness. The water it contained, coming direct from Jangi-schahr, was stationary, and consequently quite clear. This old river-bed was called the Kona-darja or Kona-jaman-jar. The road crossed it at the village of Bogha-achun-lengeri, where it was also spanned by an elevated *arik* (irrigation canal), likewise fed by the Kisil-su. The road here was splendid, hard and dry, and led through an avenue of willows (*suget*) and poplars (*toghrak*), bordered on both sides by canals, which kept the vegetation fresh. The country hereabouts was very well cultivated, though not at all thickly inhabited.

On our left we next had the principal channel of the Kona-darja, and on our right a branch of the same. The latter, which in the district of Jajlak was known as the Kelvetschuk-darja, goes as far as Fajs-abad; and as its water is derived from the Kisil-su, it was extremely muddy, and flowed at the bottom of a trench  $3\frac{1}{2}$  meters below the level of the adjacent country. Its sharp-cut banks were

in places steep, but in others shelved gradually down to the water, and were overgrown with meadow-grasses. The volume in this side-arm amounted to about 12 cubic metres in the second. At the little bazaar of Jajlak our road crossed the stream, there called also the Fajs-abad-darjasi, by a handsome, well-made bridge of a single span. It is constructed of stout beams stretching from bank to bank, with planks laid transversely across them, and is provided with a parapet on each side — one of the most serviceable bridges I have seen in East Turkestan. At the bridge the stream measured 11 m. in breadth, and had a mean depth of 1 m. and a velocity of at least 1 m. in the second.



Fig. 3. STREET IN KASCHGAR.

We now had on our left the Fajs-abad-darjasi and on our right the Kisil-boje-darja, which also derives its water from the large deltaic arm on which Jangi-schahr stands. In this way the country is traversed and watered by a system of radiating deltaic arms or canals, all pointing, like fingers or tentacles, towards the east. For a correct understanding of this complicated irrigation system, it is not sufficient to cross over the several arms, but one must follow them first up and then down,

until one sees distinctly where they begin and where they terminate. The large canal of Kan-arik, which draws its water from the Ges-darja, lay to the south of our route.

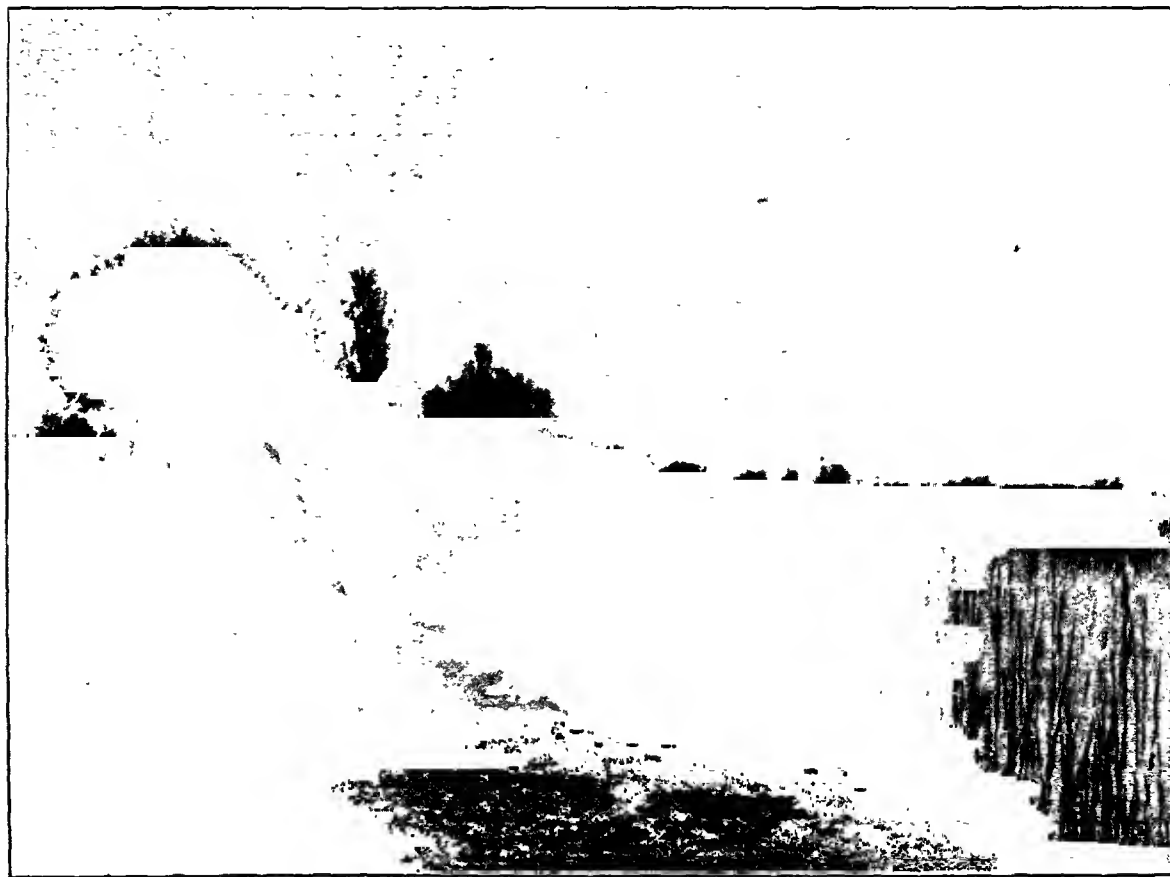


Fig. 4. THE FAJS-ABAD-DARJASI.

After passing a tract characterised by a few scattered orchards and cultivated fields, we came to more open country, where good pasturage abounded on both sides of the road. As the only bridge across the Kisil-boje consisted of two tree-trunks, we preferred a ford, where the river was 26 m. broad, and had a mean depth of 0.60 m. and a mean velocity of 0.80 m. in the second, and consequently a volume of about 12.5 cub. m. in the second. The bottom consisted of soft, fine mud, into which the camels sank deeply, so that we were obliged to lead them across one by one, and use the utmost care in doing so. On the other side of the stream the track continued to be uniformly good, except that it was crossed at intervals by ariks with a soft muddy bottom. The avenues of trees had now for the most part ceased. The horizon all round was generally dotted with groups of trees, though they were at a considerable distance from our line of march. Here are the villages of Il-kitschi-öjle and Dängaltschi. Between the latter and the village of Jangi-arik stands the *masar* or saints' tomb of Kara-kan-patschim, crowned with the usual cupola. After that we crossed the Kan-arik canal, which near the village of Madscha is

Pl. I.



*Ljustr. A. B. Lagretius & Westphal.*

THE KISIL-BOJE-DARJA.



called Tukku-su. From it is derived the water which irrigates Jangi-arik. Thus we were now in contact with the system of the Ges-darja. The canal continues to Terem and Moghal, and sends off an arm which supplies Jupoga. Higher up this big irrigation artery lie the villages of Bore-kitaj, Urum-basti, Ökesch, Janje, and several others. The village of Kan-arik possesses a large and lively bazaar, in which the products of the district, such as cereals (especially maize and wheat), fruits, cotton, and so forth, are bought and sold. The estimates of the population of the place differ widely, and consequently cannot be relied upon. In 1895 I was told that it embraced 1000 households; in 1899 the beks, or begs, of the town asserted that it exceeded double that number. Any way Kaschgar, which is situated in a relatively sterile and badly watered region, derives a large portion of its natural supplies from this fertile district.

At Kan-arik I turned off from my route of 1895, leaving it to the south, and proceeded direct to Jupoga, which I had not visited on the former occasion. The road now traversed a magnificent avenue of willows, mulberry-trees, and poplars, standing so close together as to plunge the track into deep shade. The poplars, which were of the ordinary kind, were here topped, or pollarded, to prevent them from getting too tall; and their branches, all growing straight up, formed a sort of inverted tassel or sheaf. For long stretches the foliage was so dense that the road resembled a tunnel of greenery, through which not a single ray of sunshine was able to pierce — most cool and refreshing on that hot autumn day. From the kischlak of Kan-arik the road runs direct to Fajs-abad.

For a couple of hours after leaving Kan-arik the country is desert, partly flat sand dotted with tussock-grass, partly *schor*, or moist saliferous ground destitute of vegetation. Then we came to the villages of Jangi-arik och Jek-schamba-basar, and beyond them again was the desert. The sand-dunes we here encountered, sporadic outliers of the sandy desert to the south and south-east, were not more than 3 meters high and presented their steep faces towards the east, indicating that at that season of the year the prevailing winds came from the west. Next we passed through the villages of Toktaka and Kalta-jajlak. Between the latter and Kajgulla, a village belonging to the district of Jupoga, were extensive fields of maize. Here we had on our right an arik which shed off from the Kan-arik; it was some 3 meters wide, and carried a considerable volume of water. We crossed it just before entering the village of Jupoga, with its houses of adobe or sun-dried bricks, its gardens and orchards, its fields of maize, and reservoirs for holding the overflow-waters of the Kan-arik. The year of our visit the canal was said to carry a less quantity of water than usual; in fact, there was barely sufficient for the needs of the place. Jupoga, with its associated villages, was reputed to embrace 2000 families, each of 4 to 10 members, an estimate which is undoubtedly too high. At any rate Jupoga is not bigger than Kan-arik. Here the usual cereals are grown, except rice, for which there is not sufficient water.

Irrigation is supplied by the Ges-darja, coming *via* Tasghun and Kan-arik. For twenty days every summer it is continued on from Jupoga to Terem and Moghal, and the time of our visit fell about a month after the supply to these places had been cut off. Whenever there is sufficient water to admit of it, more than a twenty

days' supply is allowed. In the autumn however, when Jupoga has fully satisfied all its requirements, the current is allowed to flow on to Terem and Moghal; but it is then of course practically useless for the crops. In years of great scarcity the people are compelled to have recourse to wells.

From Jupoga one road goes due north to Fajs-abad, and another south-south-west to Atschik. According to the native mode of reckoning, it is 50 *jol* to the former place and 40 *jol* to the latter, or in our reckoning 32 and 21 kilometers respectively.\* A third road runs from Jupoga to Moghal, and on through Avat to Mejnet. It was however reported to be difficult for camels by reason of the salt

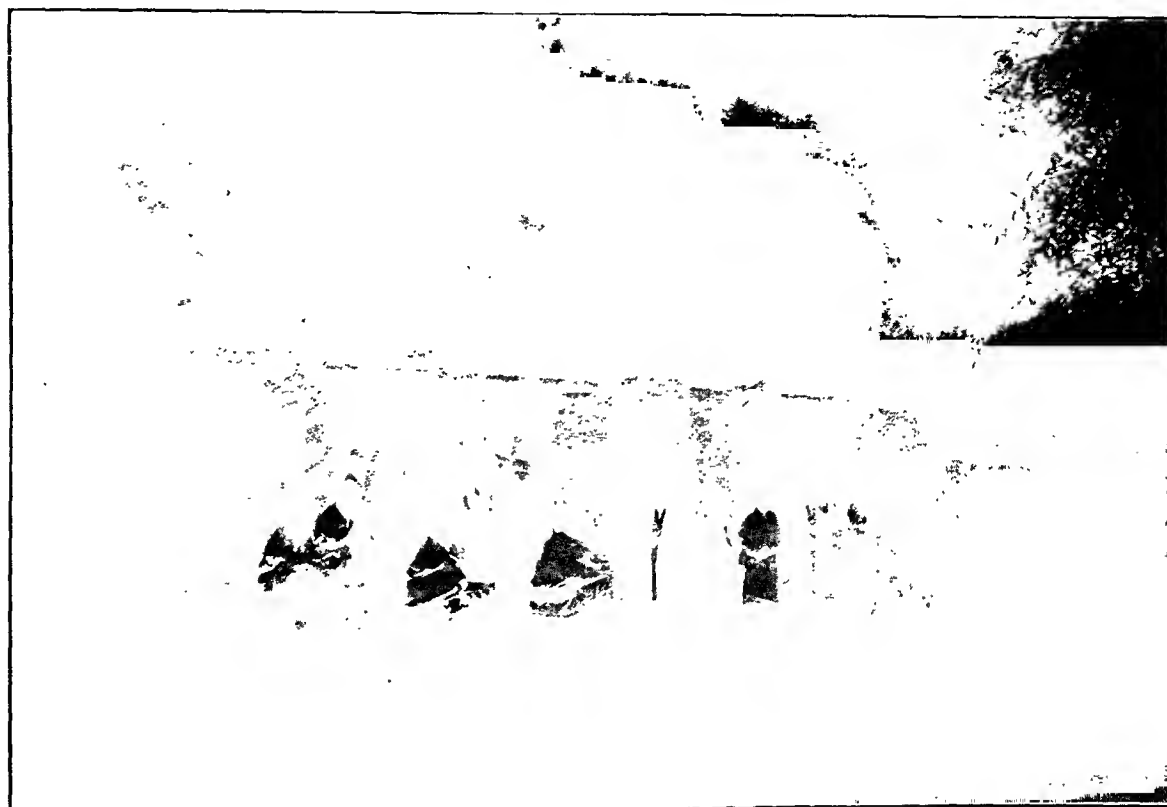


Fig. 5. COURT OF A SERAI IN KAN-ARIK.

\* In Jakub Bek's time distance was measured in West Turkestan *tasch* (stones), but since the Chinese again became masters of the country, the unit of measurement is the *potaj*, which is reputed to consist of 10 *jol* (»routes«). I have calculated that the average length of a *potaj* is 3661 metres, or  $3\frac{2}{3}$  km.; but the actual length varies greatly according to the configuration of the ground. Where the contours are heavy, the *potaj* is only a short distance; on level ground where the going is good it makes a pretty long stretch. Between the longest and the shortest of the *potajs* I measured there was a difference of fully 900 metres, so that this unit of measurement is of no value for topographical purposes. For instance, the distances 32 km. and 21 km. in the text would, on the basis of 3661 meters to the *potaj*, amount to only 18.3 km. and 14.6 km. respectively. Thus the real length of the *potaj* and of the *jol* is only to be ascertained by actual measurement. As a rule the natives of East Turkestan have not the faintest idea of distance, and you soon find that in practice the best thing is to confine yourself to asking how many days' journey it is to such and such a place. In this way you can usually learn, how long a time is required to traverse the distance with camels, horses, or asses, or to cover it on foot, say, between sunrise and the hour of the last prayer, or the usual supper hour.

Pl. 2.



*Illustr. A. B. Lagodins & Westphal.*

THE DESERT IN THE NEIGHBOURHOOD OF KARA-KUM-KUDUK, BETWEEN TEREM AND LAJLIK.





and marshy ground it traverses and the ariks being destitute of bridges; besides, it is longer than the route via Terem. Beyond it on the north stretches a barren and uninhabited desert of flat sand.

On the 9th September we travelled from Jupoga to Terem. Leaving behind us the fields of the first-named, we entered upon the steppe, dotted over with scrubby vegetation. Here we met numbers of countrymen or peasants on their way to the market at Jupoga, transporting their produce on the backs of horses, mules, and oxen. Next came a very thinly inhabited tract called Jildislik, where the clay huts are surrounded by poplars and willows. Across it run several more or less barren sand-dunes, with their steep sides towards the east-south-east. Here and there were patches of maize and cotton, amongst which wound a few wretched ariks, then mostly dry, though one or two were still moist from the last overflow from the Kan-arik. Occasionally we saw a flock of sheep. Thereafter we had for some time sand on our left and a tamarisk steppe on our right. Close beside the track, also on the right, stands the masar of Habdan Busrugvar, with its fluttering streamers; and not very far from it was a little *köl* or pool, surrounded by poplars. Although the region was on the whole barren, nevertheless we came every now and again upon an isolated homestead. When the last narrow belt of sand-dunes was passed, we once more entered the steppe. The road was still good and easy, though painfully dusty. At length it began to narrow, as we came to a part where the regular traffic diminished.

At Sängelik on the outskirts of Terem we again struck the Kan-arik; it was perfectly dry, about 4 m. wide, and had a sandy bottom. The little bridges which spanned it proved however that it did carry water sometimes. The avenue which lines it consists of young trees, and is thin and full of gaps; in some places the trees are only planted on one side. The wretched little bazar of Terem was empty and deserted, all the traders and peasants having gone to the market at Jupoga. On the eastern outskirts of the village, which are known as Koselek, we found a *köl* or reservoir, artificially made and surrounded by a rampart of earth, and not more than 0.6 m. deep. It had been filled thirty days previously, and the water still remaining in it was estimated to last ten days longer. When it gets empty, the people dig a well in its deepest part, and reach fresh water at a depth of 1.7 m.; though a short distance from the reservoir it is necessary to go down 5 m. before water is reached, and even then it is not perfectly fresh. The twenty days' supply from the Kan-arik was nothing like enough for the needs of the village; while of the violent downpour which we had encountered on the 5th September, nothing more than a fine drizzle had reached the vicinity of Terem.

Next day we soon left behind us the last homestead and well, and had nothing but the barren desert in front of us. At the same time the extreme arteries of the irrigation-system came to an end, and the outlines of the mountains disappeared in the dust-haze. The vegetation also gradually died away, and the bushes grew smaller and smaller. Here was the well of Kara-kum-kuduk, then perfectly dry, it having been abandoned several years ago. It was said to have been fully 12 m. deep at the time it was in use. Another well however, Mahametning-kudughi, did contain water, which, I found, had a temperature of 15°.8 C. The surface consisted

of sand and dust, and the track was easy to follow. On our left we had low sand-dunes overgrown with vegetation; this is called *kara-kum* or »black sand». On our right the sand is barren; this is called *ak-kum* or »white sand». Between these two expanses of sand the road ran along a narrow strip of steppe, a sort of continuation of the chain of oases watered by the *Kan-arik*. At length however vegetation grew more abundant, though it consisted only of tamarisks, dead as well as living, growing on their characteristic conical pedestals, and thinly scattered toghraks or poplars, with short stumpy stems, several of these also in a state of decay. After crossing a belt of sand with continuous and regularly formed sand-dunes, which consistently turned their steep faces towards the east and south-east, we approached the caravanserai of *Lenger*. This consisted of two small huts, overhung by poplars, a *köl* or reservoir, and a canal coming from the *Jarkent-darja*, which is said to leave the left bank of this river about 6 *potaj* above *Lajlik*. We formed our camp, which was to be the starting-point of our long journey down the river, about half an hour north of the station (*örtäng*) of *Lajlik*.

## CHAPTER II.

### THE JARKENT-DARJA FROM LAJLIK TO KURUK-ASTI.

After this short introduction, which has carried us from *Kaschgar* to the threshold of the region that is to be described in the course of the present volume, I now pass to an account of the *Jarkent-darja*, or, as the river is called after its confluence with the *Ak-su-darja*, the *Tarim*.

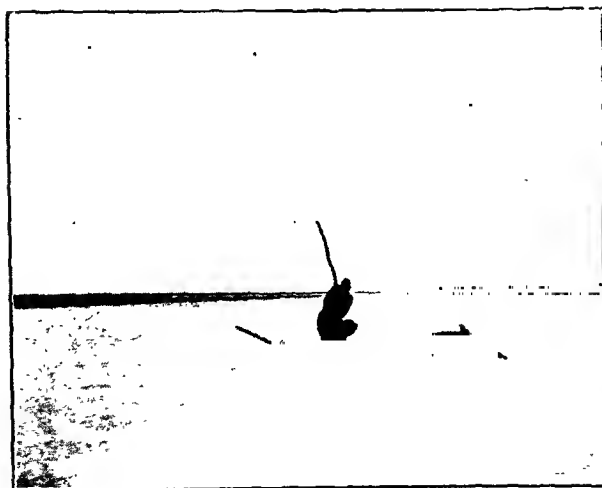


Fig. 6. THE STERN OF A FERRY-BOAT CROSSING THE JARKENT-DARJA.

My investigations into this river fell in two separate periods, the first extending from the 17th September to the 7th December 1899, the second from the 19th May to the 21st June 1900; and they were made from an ordinary ferry-boat of the type which is commonly employed in the district of *Jarkent* for crossing the river on the great caravan routes. It was 11.51 m. long, 2.37 m. broad, and 0.83 m. deep, and was constructed of planks of poplar-wood. As the only means of progression I used was the river, my itinerary was of course entirely determined by the velocity of the stream, which is naturally

subject to considerable variation according as it is affected by the inclination of the surface, the accession of tributaries, the volume, the age of the channel traversed, and so forth, in a word, by the various factors of a physical-geographical character which will be all discussed in the following pages. On the other hand I disregard the effect which the atmospheric and similar conditions have upon the rate of flow of the current. The parallelism, which unquestionably exists in this respect, can be deduced directly from the meteorological tables contained in another volume of this work. I would merely observe here, in this connection, that the volume of the stream depends upon the season, in such a way that high water follows upon the melting of the snows, and is then succeeded by low water; that the maximum volume is found in different sections of the stream at different periods, a consequence of the river's great length; that the formation of the ice and its break-up are dependent upon the temperature of the atmosphere; and that the distribution of the atmospheric pressure, the direction of the prevailing winds, as well as the storms, may to some degree at least exercise a varying effect upon the rate of the current. Nor are these the only external conditions by which the volume is determined. It is also affected by the presence of marginal lakes or lagoons, which, when they are present in considerable numbers, very appreciably retard the period of high water, so that, for example, in the lowermost reaches of the Tarim, this period occurs three or four months later than it does at the confluence of the Ak-su-darja with the Jarkent-darja, and five months later than it does in the Raskan-darja. Yet what relation exists between the volume of this river and the progress or decay of agriculture in the oases of East Turkestan, or how far the one is dependent upon the other, is not easy to say, owing to the absence of trustworthy and sufficient statistics. But that the complicated system of interlacing irrigation canals, which circulate over the greater part of the area of these oases, must of necessity diminish the volume of the river before it reaches its termination at Kara-koschun, does not admit of any doubt.

The task therefore which I have set myself in the following chapters is to present a detailed description of the geography of the Tarim. I shall deal with the river-bed and its varying conformation in different parts of its course, as well as with the changing character of its erosive action upon the surface of the regions it flows through. The bends or sinuosities of the river, its silt-beds, its alluvial deposits, its banks or erosion terraces, and their varying character according as the stream makes its way through forests, steppes and sand-deserts, or washes the foot of detached mountains; the highways, the riparian population and all that concerns them, the irrigation canals, the navigation of the stream, and its fisheries — all these will be successively dealt with as far as my observations, and the information I gleaned about them, will admit. And I shall everywhere give the geographical names which are used in connection with the river itself, or in the immediate vicinity of its banks. Still, the main channel, and the hydrographical relations of its current, will be the principal subjects of consideration throughout. Indeed, considering my means of locomotion, namely that I travelled by boat, and had neither horse nor camel to ride, I cannot very well discuss anything else except the river and the circumstances connected with it. Apart from the actual drift down-stream, I have nothing to record except one or two short trips on foot or in my sailing skiff.

When we have thus the detailed description of the Tarim and its hydrographical phenomena before us, we shall be in a position to gather up the results in a general survey, and draw such conclusions as the data suggest, as well as to consider the relations which exist between the river and the general relief and slope of East Turkestan.



Fig. 7. RIGHT BANK OF JARKENT-DARJA AT LAJLIK.

At the point where I began my journey, immediately below the station-house of Lajlik, barely one half of the river-bed was on 16th September actually under water; and the current ran close to the right bank. The channel is therefore deeply trenched, and overhung by an almost vertical erosion terrace  $2\frac{1}{2}$  m. high. Immediately under the left bank is a disconnected arm, containing stagnant water; and between this and the active current is a dry mud-bank or silt-bed. Both banks of the river are overgrown with bushes and young forest, frequently thick and tangled like thickets. The road to Maral-baschi runs along the left bank, touching tangentially those loops of the winding river which point to the west.

The actual current had there a breadth of 134.70 m. and a volume of 98.2 cub. m. in the second. The channel was very regular, and by far the greater portion of the current kept, as I have said, to the right bank, that is to say, the concave or peripheral boundary of the loops which project towards the east, and where consequently the erosive power of the stream was most conspicuously manifested. Dividing the bed of the river into three transverse sections of equal breadth, I found



RIGHT BANK OF THE TARIM, OPPOSITE TO LAJLIK.



*Ljustr. A. B. Lagrelius & Westphal.*

GROUP OF NATIVES IN THE CAMP.



that the one on the right carried a volume of 70.6 cub. m. in the second, and had a mean depth of 2.03 m. and a mean velocity of 0.846 m. in the second; that the middle section had 23.915 cub. m., with a mean depth of 0.53 m. and a mean velocity of 0.893 m. in the second; while in the left-hand section the volume amounted to 3.753 cub. m., with a mean depth of 0.34 m. and a mean velocity of 0.24 m. Thus, while the stream was decidedly shallow next the left bank, its maximum depth, under the right bank, amounted to 2.74 m.



Fig. 8. PREPARING OUR FERRY-BOAT AT LAJLIK.

With the view of facilitating the use of the map, I intend in my descriptive text to adhere to the diarial form in which my observations were first recorded; each camp where we stopped for the night is indicated by name, with the date attached, on the map itself.

On the 17th September we traversed two fairly sharp loops or curves, with broad alluvial deposits lining the convex or inner bank in each case. The natives, rightly enough, regard these sharp bends, round three sides of which the river winds, as peninsulas. Hence the first name we met with after leaving Lajlik was Araltschi or »the Island-like», from *aral*, an »island». Here the banks were planted with young forest, low and tangled, and thorny bushes. The banks (*kasch* or *jar*) were as much as 3 m. high. These forest tracts generally bear a different name at each bend



of the stream, and these it was of importance to note, as they frequently throw some light upon the local topography. For instance, Arpalik-kaja tells us, that corn is grown in that district; Kakschallik signifies »dry tree»; Tonguslik explains that wild-boar frequents the vicinity, or once did so; and Kalmak-jilghasi perpetuates the traditions of Mongols (Kalmucks) having once dwelt there. Muhammed-Ili-lenger is the name of a caravanserai, standing on the great caravan-route amid a grove of tall, slender poplars. Other names which figure in the forest nomenclature are Ara-koscha and Ghasanglik. The former marks the point of issue of an irrigation canal (*arik*), which runs west to Avat, though it only carries water in the height of the summer; indeed I think it very doubtful whether the canal really does reach the oases at all. At all events, in the course of an excursion which I made there on horseback in 1895, I remember encountering two dry river-beds, which the canal would of necessity have to get across.

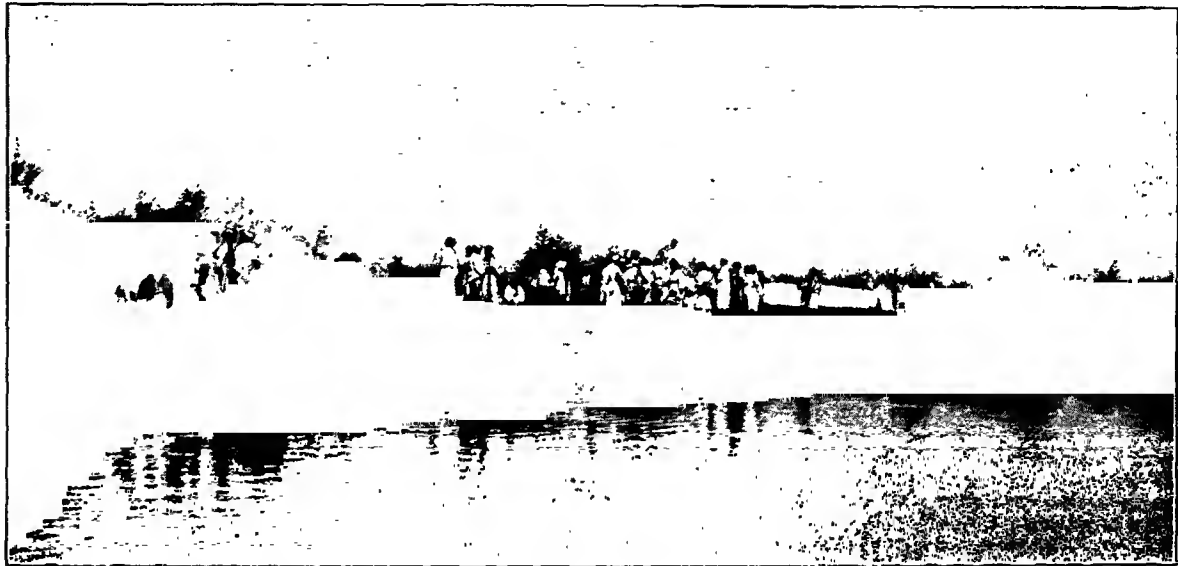


Fig. 9. BUILDING A FERRY-BOAT ON THE BANK OF THE JARKENT-DARJA.

At Muhammed-Ili-lenger the river had two years before altered its course for a short distance. The channels which the stream thus abandons are known throughout the whole of the Tarim region as Eski-darja or Kona-darja (Old River), while the new channel is called Jangi-darja (New River). At the beginning of this 'old river' there was a pool of water (*köl*). When it contains water, an old channel of this kind is known as a *boldschemal*. And these abandoned loops or *partes relictæ* of the river, caused by its seeking a new channel for itself, are very common all the way to Abdal. Every year the stream changes its course somewhere or other, often in several places more or less simultaneously. Hence, strictly speaking, the map which I laid down, and which is reproduced on a reduced scale in the accompanying atlas, cannot claim to represent the actual course of the stream for any great length of time. Some of the loops in the river approximate so closely to a complete circle, that the narrow neck of land remaining would hardly be able to withstand the full flood of the following year. In other localities, where the river-



*Ljustr, A. B. Lagrelus & Westphol.*

RE-CONSTRUCTING THE FERRY-BOAT. RIGHT BANK OF THE TARIM OPPOSITE TO LAJLIK.



bed is straight, as well as deeper, there is every likelihood of the stream flowing on unchanged for a score of years, or more. Were another map of the river to be constructed twenty years hence, and to be compared with this which I have been enabled to execute, we should be able to perceive to what extent, and in what directions, the stream had altered its course in the interval; and should moreover be in a position to estimate its erosive energy, and measure the mass of its alluvial deposits, as well as to infer the law which from time immemorial has governed its excavating power.

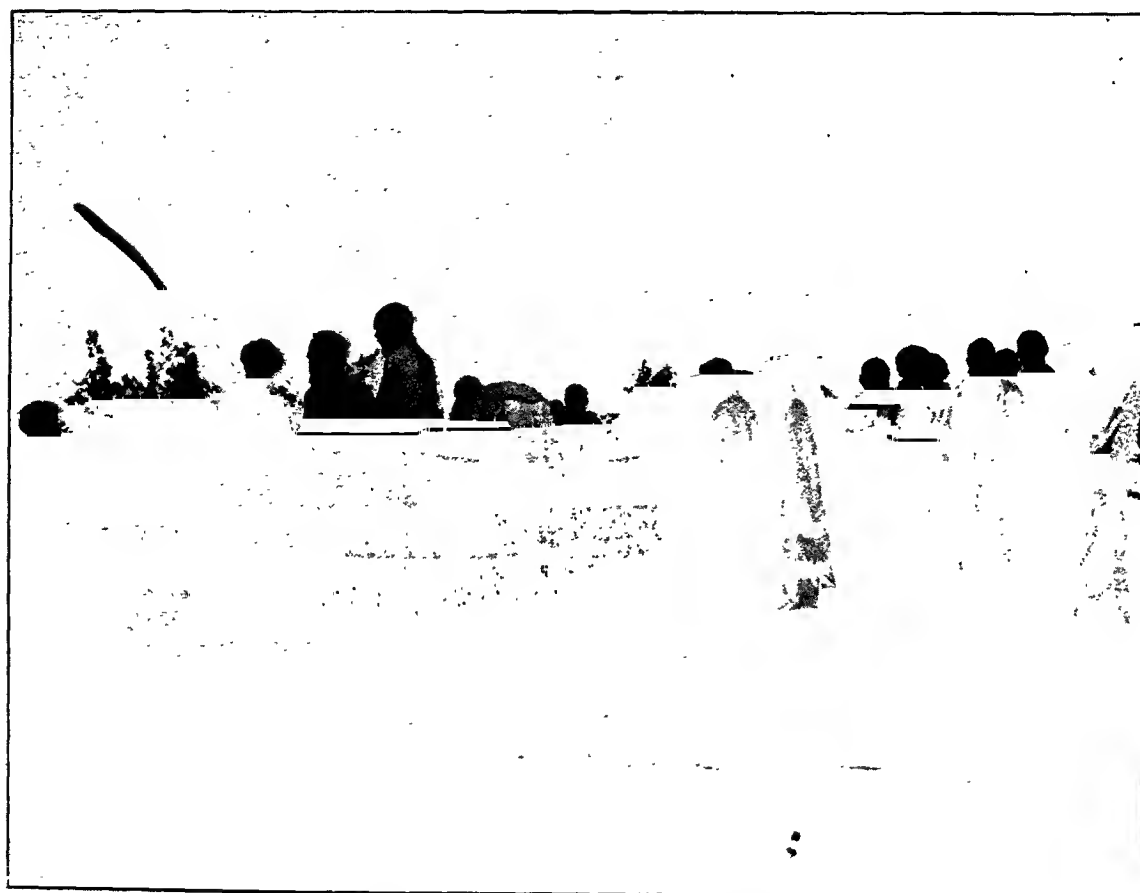


Fig. 10. GROUP OF NATIVES AT LAJLIK.

In the region where my journey upon the Tarim commenced, the current flowed at a gentle rate, the fall from Jarkent downwards being inconsiderable. I measured the velocity several times a day. During the first day's journey it amounted to 38.2 m. in the minute; and continued to decrease all the way to the confluence of the Ak-su-darja. It is self-evident, that at the period of high water the velocity is very much greater, and that, had I embarked upon my journey at that season, my progress would have been very appreciably quicker. But the autumn possessed this advantage over the summer, that, large portions of the river-bed being exposed, I was enabled to study its conformation with greater convenience. As a rule the stream drops intermittently in the autumn, the daily decline being but trifling, as we were easily able to see by studying the sharp-cut edges of the miniature banks round the exposed silt-deposits. Although the erosive power of the current dimi-

nishes in the autumn, still the evidence of its disintegrating effects upon the 2 to 3 m. high banks was easy to see along those stretches which received the impact of the main body of the water (which of course moves the fastest) in the not inconsiderable masses of earth which every now and again plunged into the stream, and were swept away, to be deposited elsewhere lower down.

On the 18th September we again navigated two big loops pointing towards the west. In the straight reaches the bed was narrower, the flow more equable, the depth more uniform, and the alluvial formations relatively insignificant. In the first of the two loops just mentioned the channel was, on the other hand, very broad, and the flood had to find its way amongst vast deposits of alluvium and exposed silt-beds. The banks still continued to be set with young forest (*toghrak* or poplars) and bushy undergrowth. In many places the roots of the trees projected

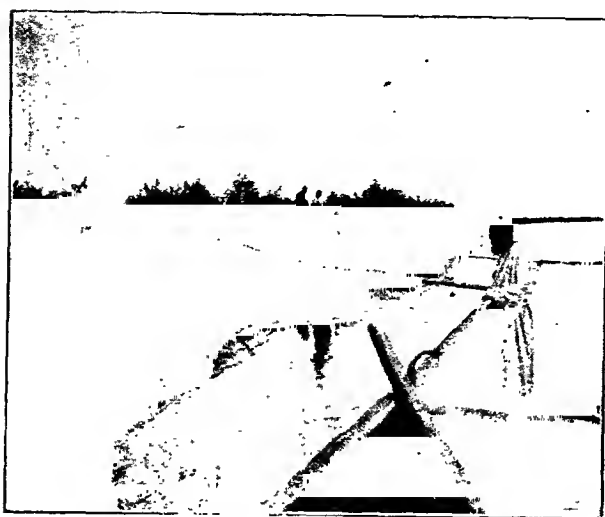


Fig. 11. RIGHT SIDE OF THE RIVER AT LAJLIK.

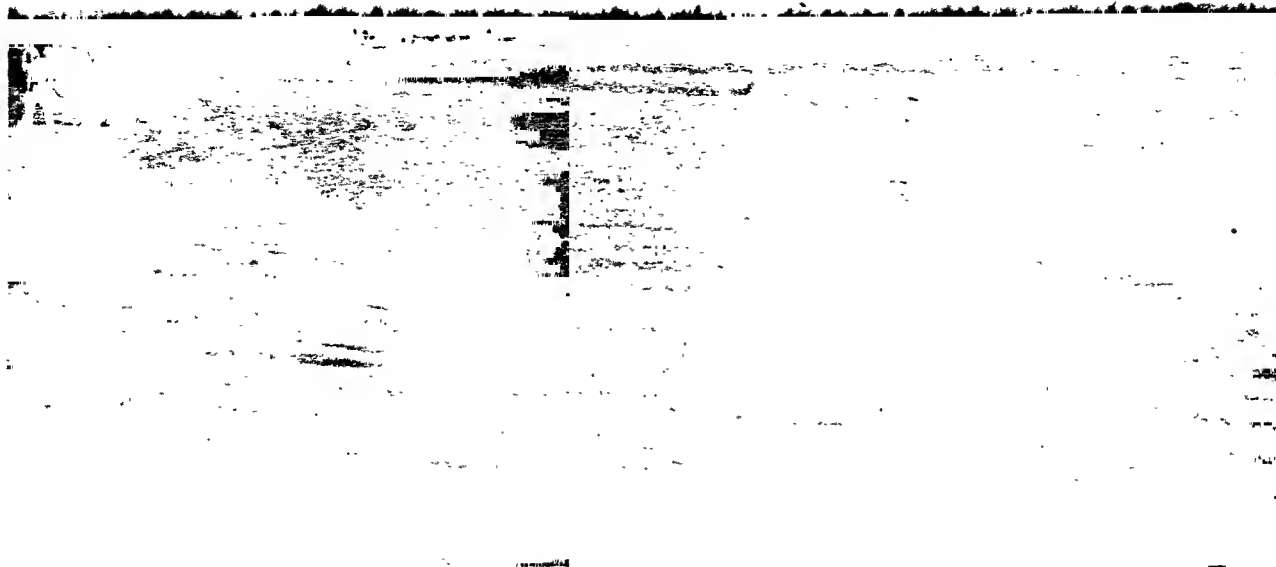
from the vertically scarped banks and trailed in the water below. The stream was too turbid to make fishing a profitable occupation. Flocks of sheep were grazing along the banks, and the shepherds dwelt in huts built of branches and foliage, precisely as their fellows do in the woods alongside the Chotan-darja and the Kerije-darja. The extremities of the west-going bends still continued to touch the caravan route to Maral-baschi. Between the two big loops which we traversed on this day, and a little bit back from the river, stood the village of Mejnet, with a station house and a bazar; and here the stream is generally

crossed, with the help of two ferry-boats, by persons using the bye-road which comes from Merket and other villages situated on the right bank of the Tarim opposite to Lajlik. During the course of the day we passed the following localities — Kerije-tokaj, Kakschal, Atscha-kasch, At-pangsa-tokaj, Araltschi, Kara-tokaj, Mejnet, Bisch-jol-tschakil, and Bisch-köl. At the last-named the river was 86.40 m. wide, its maximum depth 2.22 m., its mean depth 1.229 m., mean velocity 0.7544 m. in the second, and its volume 80.09 cub. m. in the second. This shows how swiftly the river falls on some days in autumn; though it must also be observed, that in the day's journey the river parted with some of its water to the irrigation channels which are there led off from it.



Fig. 12. Left. 0.76      0.98      1.06      1.06      1.78      2.22      1.97 = depth. Right.  
                  40      64      63      81      96      92      95 }  
                  61      62      71      71      89      88      89 } velocity. \*  
                  Breadth = 86.40 m. Bisch-köl, 18 Sept. Scale = 1 : 600

\* Explanation, see p. 28:



RIGHT BANK OF THE TARIM, SEEN FROM THE LEFT BANK, A LITTLE BELOW LAJLIK.



*Ljustr. A. B. Lagrelius & Westphal.*

NATIVE MUSICIANS AND DANCERS AT LAJLIK.



September 19th. At first the river flowed due north, afterwards almost due east. The accompanying forest, although it grew a little thicker, still remained less than 4 m. in height. The vertical face of the containing banks seldom exceeded  $1\frac{1}{2}$  m. The nomenclature bears witness in the name Kum-tokaj (Sand Forest) to the arenaceous character of the surface. Kosch-toghrak (Double Poplar) derives its name from the fact that the great caravan road passes there between two high poplars; the same district is also called Kosch-otak. There too a mill is driven by a little canal issuing from the river. In that same locality the stream is very broad and expanded. Immediately below the place last named a canal strikes northwards from the river and irrigates the fields of Jeren-patti, where the shepherds grow maize and wheat. At Schäschkak there are old and lofty poplars; the place is inhabited by four shepherd families, owning some 200 sheep, besides a number of goats and cows. These people also carry on some agriculture, their fields, which lie on the right bank of the river, being watered by a canal which quits it at Bisch-köl. The information which I gathered during the course of the day is not devoid of interest. For instance, I was told that the river had reached its maximum flood two months before the time of our visit, that is to say, about the 20th July; and since that date it had been subsiding, at first slowly, but later on more rapidly. It was expected to freeze there in about 75, or at the most 80, days. There too the ice is wont to remain for three months. After the ice melts, and after the water thus liberated has flowed away, there remains so little in the river that its bed can be forded in several places.



Fig. 13. THE FERRY-BOAT A LITTLE BELOW LAJLIK.

At Schäschkak the current was very narrow and deep. Its breadth amounted to 42.6 m., of which a portion, 5 m. across, next the left bank, was dead, that is to say, it had no current. The maximum depth was 3.90 m., and the mean depth 2.274 m. The mean velocity = 0.6608 m., and the volume 64.01 cub. m., in the second. Thus the river still continued to show an appreciable fall. At our camp the face of the right bank measured vertically 2.30 m.

During the night the level dropped 1 cm.; but during the next following night it rose again at the same place  $1\frac{1}{2}$  cm. These oscillations would seem to depend

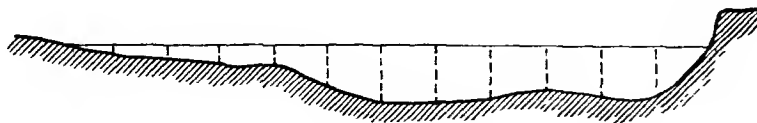


Fig. 14. Left. 0.52 0.81 1.22 1.17 2.87 3.90 3.76 3.62 2.95 3.20 3.27 = depth. Right.  
 40 54 45 60 50 57 89 81 91 89 70 }  
 41 33 34 66 72 79 91 84 80 66 } velocity.  
 63 83 85 76 84 56 65 }

Breadth = 42.60 m. Schäschkak, Sept. 19. Scale 1 : 500.



partly upon an accession of water from the mountains and partly upon the distribution of the atmospheric pressure over the lowlands.

September 21st. The river still maintained the same characteristics. We stopped for the night at a sharply accentuated bend. Amongst the geographical names was Jolbars-kotan (Tiger-hut), showing that tigers once frequented the locality, although at the present time they are rare visitants there. At Schejtlik there is a good, close-growing poplar wood, and shepherds graze their flocks in the vicinity. Although their huts are as a rule erected close to the river for the sake of its water, it was difficult to obtain any idea of their numbers. Other geographical names which occur in this district are Boghu-patti, Nakas, Dukan-toghrak, Kisil-sepetsch, Daschi, and At-pangsa. At the sharp turns the depth was as much as 5 or 6 m., and in this part of its course the river winds about in every direction. At our night-camp the breadth measured 69.3 m., the maximum depth was 2.30 m., the mean depth 1.434 m., the mean velocity 0.5382 m., and the volume 53.47 cub. m., in the second. The sharper the bends the higher and the more scarped are the banks here, for example  $2\frac{1}{2}$  m. high.

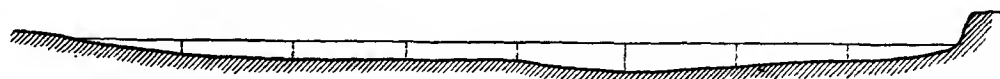


Fig. 15. Left. 

1.10	1.50	1.58	1.63	2.30	1.89	1.47 = depth.
42	51	62	71	73	63	54
38	36	61	64	57	74	39

 Right.  
Breadth = 69.30 m. At-pangsa, Sept. 21. Scale 1 : 600.

September 22nd. A small canal, led off from the river a little below Bereghes (to turn a mill), issued through a deep cutting in the right bank and still contained water, proving that the country on that side of the river lies lower than the stream even at the season of low water. During the past night the level had not changed in the slightest degree. In places the forest was now quite dense, and the trees of great size. This was especially noticeable at the sharp elbows of the stream, where the erosion was most pronounced, the water having, as it were, eaten its way into the forest. The outermost angles of the opposite bank were filled with the crescent-shaped alluvial deposits left by the stream, and on the shore side of these there were of course only young forest and brushwood. It was at the apexes of the sharp bends, too, that we measured the greatest depths, caused by the eddies which are there set up in the current. Indeed the river always exhibits a considerable depth in such places, even in spring. The backwater, or 'dead'-water, which we sometimes encountered on the surface, is called by the natives *köl*, i. e. 'lake', in contradistinction to *akin*, *darja*, or *tarim*, the names they give to running water.

Below the mill I have mentioned the right bank bears the name of Kök-köl. Then comes, on the left bank, Tongus-öldi, with a stagnant pool, and beyond it in succession Kalingning-dschaji, Korum, Ala-ajgir, this last with a station-house on the great caravan highway, and a ford which is used in the spring. The depth immediately below the ford amounted to  $5\frac{1}{2}$  m. Further on lie Tschürge and Schakkalotak. A Kona-darja or Old River, dry when we passed it, which issues through the right bank at Korum, extends due east towards the sandy desert, and seems

to imply that at some time or other the river has here for a space shifted its course to the left, i. e. to the west, contrary to its habitual tendency, which is to select new channels for itself towards the right. This dry bed which leaves the river at Korum is unquestionably identical with the sheets of water which I chanced upon in the desert on 14—16th April 1895 about 30 km. east of Ala-ajgir.\* Notwithstanding the name of Kona-darja given to them they did not constitute a regularly formed and connected river-bed.

Were it the survival of a former overflow channel of the Jarkent-darja, its bed would still admit of being traced. Now the natives seldom err in their information with regard to such things, so that I am quite disposed to believe, that the sheets of water which I discovered in 1895 had their origin in some unusually extensive overflow of the river coming from the neighbourhood of Korum. In that case, the Kona-darja would really mark the beginning of a new, and not the beginning of an old, bed, into which the current will by degrees eventually transfer itself. And we shall soon find, that movements of this character towards the right have already taken place in other localities.

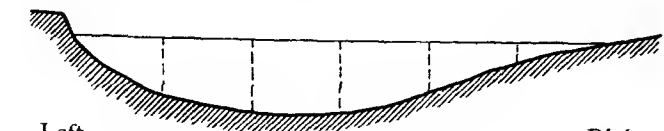
During the course of the day the river grew both narrower and deeper, while the current at the same time flowed more slowly. At Schakkal-otak, the breadth only amounted to 35.3 m.; the maximum depth was however 4.98 m. and the mean depth 2.965 m.; the mean velocity 0.6322 m., and the volume 66.16 cub. m., in the second. These results are not however altogether reliable, owing to the fact that for such an appreciable depth the velocity readings were not taken sufficiently close together along the vertical line; for in all probability the velocity at the lower depths was inconsiderable. Anyway an increase of 13 cub. m. in the volume on the previous measurement does not seem likely. The Schakkal-otak results are therefore too high.

September 23rd. In this part of its course the surface of the Jarkent-darja was copiously littered with driftwood. In many places an entire poplar had fixed itself in the river-bottom, and, by arresting the floating branches and brushwood, gradually given rise to islands as the silt and sand concentrated around them, binding them into a consolidated mass. On each side of these obstacles the stream had



Fig. 16. FOREST ON THE LEFT BANK OF JARKENT-DARJA.

usually scooped out a deep trench, building up a ridge of silt along the continuation line of the mass of driftwood. These accumulations of driftwood nearly all come from the projecting elbows of the sharp bends, where the current, eating into the



Left.					Right.
Fig. 17.	3.72	4.98	4.77	3.09	1.23 = depth.
	80	79	71	46	0
	86	78	71	61	9
					} velocity.

Breadth = 35.30 m. Schakkal-otak, Sept. 22. Scale 1 : 600. where the current, eating into the

\* See Petermanns Mitteilungen, Ergänzungsheft No. 131, p. 239.

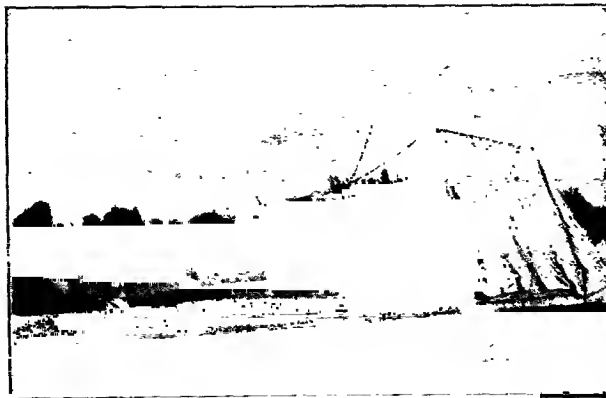


Fig. 18. DRIFT OF THE FERRY-BOAT UPON  
THE JARKENT-DARJA.

forest, undermines the trees nearest to the edge, and so causes them to topple down into the water and be swept away. Every landslide in such places carries with it masses of intertwined roots. It is at these sharp bends that the erosive power of the stream is most conspicuously displayed, not only upon the extreme face of the elbow itself, but also in the river-bed at its foot. The sharper the elbow, that is to say the greater the change of direction in the river's course, the greater becomes the

conversion of the power which is represented by the movement of the water into another species of energy, namely the erosion of the concave bank and of the river-bottom immediately contiguous to it. The sharper the bend, therefore, the greater becomes the depth of the river adjacent to it. On the opposite or convex side the work of depositing alluvium proceeds simultaneously at a corresponding rate. And in a country like East Turkestan, where the general inclination is so slight, and the surface consists of such soft and pliant materials, there exists practically no check upon the sinuous tendencies of the current. At the same time there is a period of maturity naturally prescribed for each bend; for if each loop or elbow is regarded as a peninsula, then its root, or connecting isthmus, becomes assailed from both sides at once; the opposite margins gradually approach one another, until there is only a narrow neck or mere strip of land left between them, and finally this becomes so weak that it is unable to resist the next flood, and is consequently cut in two. In this way what was originally a loop of the river becomes

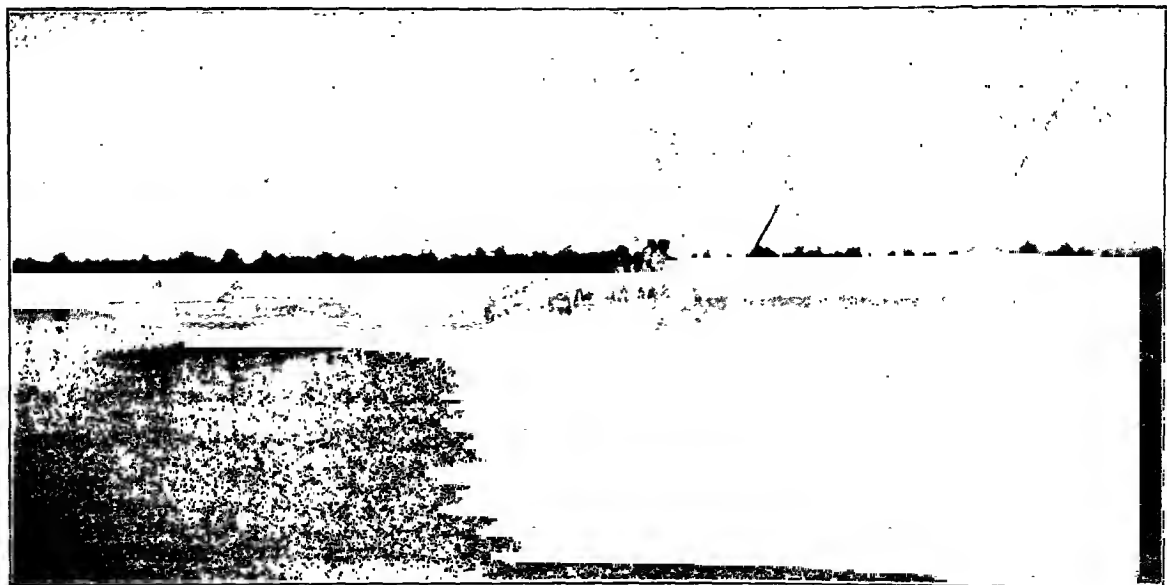


Fig. 19. ORDINARY FERRY-BOAT FOR PASSING OVER CARAVANS.

entirely abandoned, and is converted into a *boldschemal* («deadwater» or «backwater»). One consequence of this activity is that the country through which the river carves its way becomes still further levelled down. In the course of the subjoined description of the Jarkent-darja and the Tarim we shall several times have occasion to dwell upon similar abandoned loops. That the belt of forest which accompanies the Tarim is as broad as it actually is, probably depends in no slight degree upon the river's instability, and its aversion to persist for any length of time in one and the same bed.

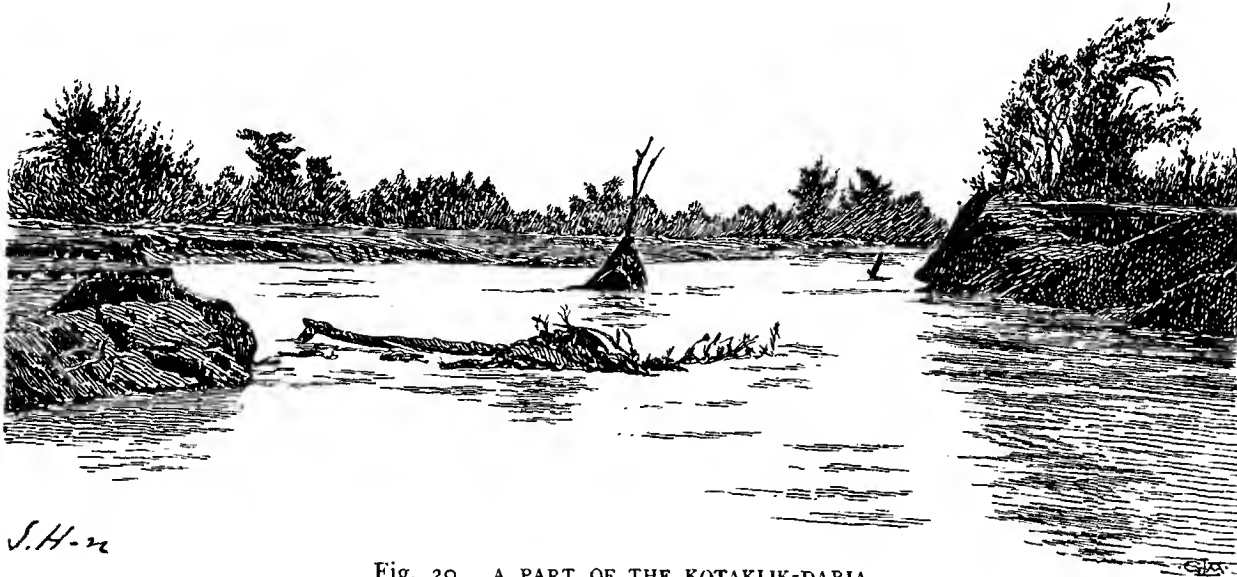


Fig. 20. A PART OF THE KOTAKLIK-DARJA.

A short distance below Schakkal-otak the river shed off on the right an arm which was 10 m. wide at its inception, and was contained between steep banks. Although shallow, it nevertheless carried, for a short distance, a volume of some cubic metres of foaming water, which however speedily found its way back into the main stream. Possibly it owed its origin in the first instance to an artificial canal, which has been gradually widened and deepened by the natural action of the water. The greater velocity of its current was due to the straightness of its bed, and the fact that it lost none of its energy in getting round extensive curves. In all probability the main current will soon gravitate into this short cut. Immediately above the point where it struck off the depth of the main stream amounted to 6 m. and more.

In this particular section of its course the Jarkent-darja displays in general an exceptional degree of restlessness and energy. Not very far below the point of bifurcation I have just dwelt upon, the river divides again, having four years previously carved out for itself a new channel on the right of its former bed. The two arms unite again virtually opposite to Aksak-maral. At the distance of one or two kilometres below the point of bifurcation there is led off from the old bed, the Kona-darja, the big artificially made canal which carries irrigation water to the fields of Maral-baschi. But since the stream abandoned the old channel, the people have found it necessary every spring to construct a dam across the mouth of the

new cut, so as to force the water of the Jarkent-darja into the bed of the Kona-darja. The dam, which is built of toghrak-trunks, branches, brushwood, and clay, is said to require 1000 men for its construction. It is however never strong enough to withstand the force of the river when in full flood, but always gives way before it and is broken. Hence, as the cultivation of Maral-baschi is entirely dependent upon artificial irrigation, the dam has to be reconstructed every spring. But no dam is required in the Kona-darja, for the canal which leads off from it on the left, and which has gradually developed into a regular arm of the river, lies at a lower level than the Kona-darja itself, so that the water naturally gravitates that way of its own accord. After some distance it enters a lake, and thence proceeds by several branches to Maral-baschi.

The new arm I have spoken of is called Kötäklik, because it is filled with driftwood (*kötäk*). The space between the two river-arms is occupied by a *kamisch* (reed) steppe. Forest is thin and rare. In the Kötäklik-darja the current was active, as it generally is in newly formed branches, owing to the fact that it has not yet begun to wind about and does not yet dissipate its energy over a long course.

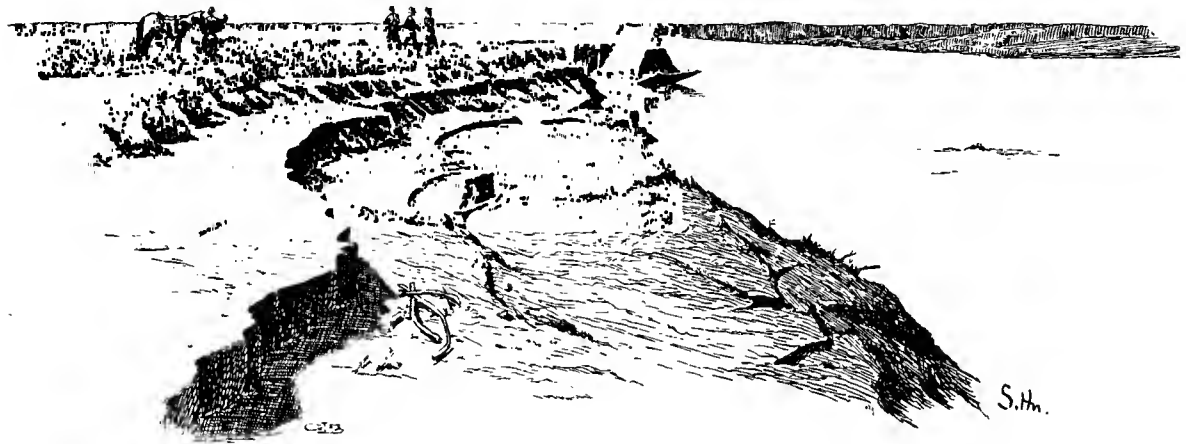
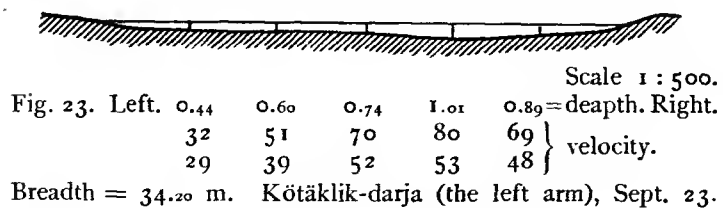
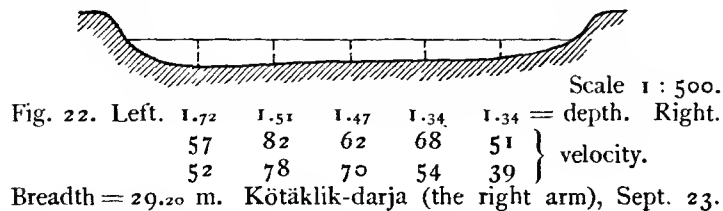


Fig. 21. KÖTAKLIK-DARJA ABOVE THE ISLAND.

In the upper part of the Kötäklik-darja there is an island, consisting, not of silt, but of firm ground, lifted tolerably high above the surface of the stream and covered with vegetation. From its upper end we measured the volume of the divided current



which flowed on each side of it. The branch on the right was 29.20 m. broad, and had a mean depth of 1.230 m., a mean velocity of 0.5715 m., and a volume of 20.53 cub. m., in the second; while the measurement of the left branch gave the following results, breadth, 34.20 m.; mean depth, 0.613 m.; mean velocity, 0.5177 m. in the second; volume, 10.86 cub. m. in the second. Thus the total volume

amounted to 31.39 cub. m.; from which we may infer how enormous is the quantity of water that still finds an outlet through the Kona-darja.

Below the island were three small cataracts, plunging down three separate thresholds athwart the current. The largest was the first, which bore the name of Schakurun, a word meaning a »waterfall» or »fall»; yet it was not more than 1 dm. high. It is indeed interesting to find that cataracts occur in this branch of the river, for it must be remembered, it is only four years since it was formed. They will no doubt disappear in time, when the channel grows deeper, and the thresholds or transverse ridges become worn away by the friction of the water. The locality where we encamped is called Kötäklik-ajaghi, or the Termination of the arm that carries driftwood.



Fig. 24. VIEW A LITTLE ABOVE THE CATARACTS OF THE KÖTÄKLİK-DARJA.

September 24th. During the night the river rose 3 mm. Not only the character of the river-bed, but also the aspect of the landscape we were traversing, showed plainly that we were navigating a newly formed branch. The containing banks were on the whole very low. The windings were short, and but little developed, though they turned at sharp angles; the river was still seeking a path for itself, and was undecided which way to turn. As yet there were no alluvial deposits worthy of the name; in some places the stream was scarcely 20 m. broad. At intervals were living poplars still standing on tiny islets; others, although fallen, still had their roots fixed in the river-bottom, and thus formed obstacles against which the driftwood was beginning to collect. Occasionally, too, tamarisks and other bushes projected above the surface, and long trailing root-fibres, fast at one end, streamed on the current. Every now and again, the river, which travelled swiftly as a rule, was broken by rapids, though none were of any consequence. The vegetation on the banks consists of bushes and kamisch and solitary young poplars; there has not been time as yet for forest to grow up. Sometimes the stream divided, but soon reunited again. During the latter part of the day's journey, the river was narrow and deep, like an artificially constructed canal, and was bordered by banks as much as 1½ m. in height. The depth amounted to 7 m. or more. On the left bank are a couple of sand-dunes, overgrown with vegetation, which bear the name of Ghorun-



S. H. 22

Fig. 25. HIGH SAND-BANK ON THE RIGHT SIDE OF THE JARKENT-DARJA, SEPT. 25TH.

dung. Beyond them comes the district of Lepscheme. Soon afterwards a minor branch broke off on the right, and then the river itself divided, the two arms being pretty equal in dimensions; but after going a few kilometres they came together again. Several of the side-arms of the main current were then dry. Then, in the district of Töländä, the river was joined from the left by what appeared to be a considerable branch, though it was then cut off from the river itself. Some stagnant water, which lay in its throat, was perfectly limpid, in marked contrast to the water of the moving current, which was grey and turbid. Beyond Töländä the current again divided so as to embrace an island, from which a couple of transverse ridges or steps stretched across the right-hand half of the stream, forming rapids. The upper rapid had a depth of 6 cm.; but their united fall did not exceed 3 dm. The bottom consisted of hard, plastic blue clay. Above the island, before the stream divides, its breadth amounted to 34.90 m., the mean depth was 1.680 m., the mean velocity 0.3431 m., and the volume 20.12 cub. m. in the second. The reason the volume constantly diminished in such a marked manner in this region was that the river was flowing along a new track, and had not yet fully made up its mind which way to go. But when these new formations ceased, and the river gathered up its energy

into one channel, instead of dissipating it in so many directions, the volume again increased, and remained more constant.

September 25th. In the district of Karaul-dung the river was not more than 6 to 7 m. wide,

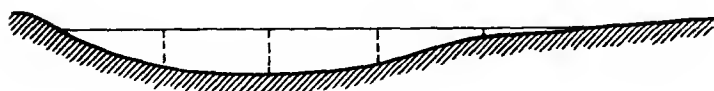
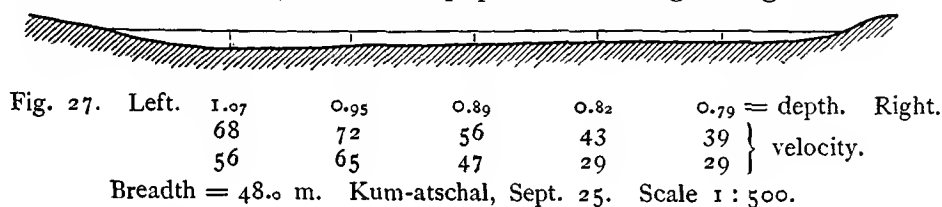


Fig. 26. Left. 2.40 3.01 2.40 0.59 = depth. Right.  
 40 44 33 10 } velocity.  
 35 40 40 }  
 Breadth = 34.90 m. Töländä, Sept. 24. Scale 1 : 500.

but deep and rapid. Karaul-dung itself is a conspicuous sand-dune, overgrown with vegetation, about 10 m. high, whence an excellent view of the locality can be obtained. We now perceived that the portion of the river which we last traversed consisted in reality of a network of arms, all reuniting at the foot of the hill. The greater part of them only carry water during the season of high flood, when they probably fuse together into one broad stream. The left bank was steppe, the right bank young forest. In the south and south-east, at a distance of one to two kilometers, we saw the extreme outlying dunes of the great »ocean of sand». In the west, on the other side of the river, is the stationhouse of Aksak-maral, embowered amongst poplars and willows. The surface of the country through which the river here ploughs its way consists of sand, and nothing but sand. In places it had cut a path through the sand-dunes, 4 to 6 m. in altitude, showing in the face of the cutting the different wind-deposited layers of which they were built up. These dunes however, owing to the vegetation which covered them, were stationary; and although a narrow strip of silt and mud had been deposited at the foot of the cutting close to the water's edge, it had not sufficient consistency to support the weight of a man. The district was perfectly uninhabited, destitute in fact of animate existence; and yet distinctive parts are sometimes not without names. For instance, there are Kuda and Kum-atschal, where a tolerably luxuriant poplar wood is growing. Here the scarped



banks were 2 m. high, and the river 6 m. deep, this measurement being obtained, as usual, in a bend. Above the same bend, where the river was 48.00 m. broad, the mean depth did not exceed 0.753 m., while the mean velocity was 0.4808 cm. in the second, and the volume 17.38 cub. m. in the second.

September 27th. During the last 36 hours the river had fallen 3.8 cm., and a new erosion level had made its appearance in the face of the escarpment. The main stream was now rejoined by one of the arms which branched off from it at Kötäklik; it is here called Atschal. After receiving this fresh augmentation, the river resumed its previous appearance — scarped banks 2 to 3 m. high, alluvial deposits, and borders of magnificent woods, interrupted now and again by smaller kamisch-beds, as well as by isolated sand-dunes, some with vegetation, others without. This was especially the case at Petelik-otak, a place where the river makes a considerable bend towards the south; there the sand-dunes burst through the forest and approach quite close to the stream, the bank being at that spot  $3\frac{1}{2}$  m. in height. Upon reaching Kum-atschal we again struck the broad empty bed of the Kona-darja, and so issued from the new four-year old Jangi-darja, which we had followed ever since we left the district of Kötäklik. The old abandoned river was, as I have just said, dry, except for a little *köl* of stagnant water at the very end of it, a survival of the stream which flows through it at the season of high flood, and then only. Indeed, its bed was in part overgrown with fresh grass, and on its left bank there were



sand-dunes carrying vegetation. The region was however still uninhabited. Eagles and crows were common, wild-duck showed themselves sometimes, and occasionally we noticed traces of wild-boar, wolves, foxes, antelopes, and hares. The forest bears in different parts the names of Ghaslik, Tatlik-jigde, and Läschlik. The woods hereabouts are exceptionally fine, the trees often lifting themselves above impenetrable thickets of bushes, reeds, and climbing plants. At our camp the Jarkent-darja had a breadth of 79.5 m., the mean depth was 0.648 m., the mean velocity 0.5910 m. in the second, and the volume 30.46 cub. m. in the second. But above this point we had passed places where the sounding-line gave depths of no less than 8 meters.



Fig. 28. Left. 0.52      0.58      0.78      0.90      1.11 = depth. Right.  
           34        50        70        92        72 } velocity.  
           32        50        65        75        60 }  
           Breadth = 79.50 m. Läschlik, Sept. 27. Scale 1 : 600.

September 28th. During the night the surface fell 9 mm. The river was here confined to a single ancient deeply cut bed, and attained in places a depth of 7 m. The forest was still dense and the trees finely grown. Although we observed the shepherd's airy huts (*söre*), we saw none of the shepherds themselves. Here, in sharp contrast to the Kötäklik arm, we again had long and tedious windings to contend against. On the whole, the river pursues a general north-easterly and east-north-easterly direction. The various sections of the forest we passed are called Ak-kum, Jaman-tokaj, Hadschi-kum, Bulung-otak, Dankan-tscholi, Tschirimdan-dung, Kujlusch, and Jalghus-jigde. From the last-named point the Korum arm, spoken of above, is about 3 km. distant to the south-east. Here again we obtained further proof of the tendency which the Jarkent-darja shows of seeking to follow that new bed; for I was informed, that every spring its upper end (*baschi*) has to be closed, otherwise the whole stream would pour itself into the new channel, and indeed, in spite of the dam, some of it does force its way in. The reason for damming it back is to prevent Maral-baschi from being deprived of its irrigation water. In years of exceptionally high flood a not inconsiderable quantity of water becomes lost in the Korum bed. Owing to the aridity of the ground it travels over, the overflow is never able to get back to the main stream, but wastes away on the outskirts of the desert. The space between the Jarkent-darja and the Korum is occupied by thin young forest, and south-east of the latter stream lies the high barren sand. At Jalghus-jigde the river was 40.80 m. broad, its mean depth 0.975 m., its mean velocity 0.5996 m. in the second, and the volume 23.85 cub. m. in the second. Here, in consequence of its sluggish rate of flow, the water in the river was more transparent than at Lajlik. A bright disk of tin was visible to a depth of 12<sup>1</sup>/<sub>2</sub> cm.



Fig. 29. Left. 1.45      1.31      1.30      0.99      0.80 = depth. Right.  
           50        68        82        95        61 } velocity.  
           39        51        79        78        50 }  
           Breadth = 40.80 m. Jalghus-jigde, Sept. 28. Scale 1 : 500.

September 29th. The drop during the night was 2 cm. The forest was less fine, older poplars occurred only at intervals; steppe predominated, with bushes and young trees. As a rule the river is margined by a thin strip of kamisch steppe next the water. At Kanscha-kum some large sand-dunes approach close to the bank, and the yellow barren desert is visible through the forest to the south-east. Here the river described a strongly accentuated loop. At Bisch-kajde there is a *masar*, standing underneath a poplar-tree, and consisting as usual of poles bearing rags, and the skulls of antelopes and deer. On the right side of the river was an abandoned loop or Kona-darja. At Mupte-toghrak and Tusluk-kasch we found shepherds with their flocks of sheep and some horned cattle. They possessed a sort of dug-out, a clumsy canoe made out of the stem of a poplar. Along this part of the Jarkent-darja both canoes and ferry-boats are extremely rare, indeed in most districts they are entirely wanting. Where this is the case, the shepherds are perforce obliged to remain on the one side of the river for at least six months, leaving the grazing on the other bank to be consumed in the winter and spring. Other names in this locality are Toschkan-tscholi and Kijik-tele-tschöl. At the last-named the breadth of the river amounted to 52.6 m., the mean depth to 0.929 m., the mean velocity to 0.5012, and the volume to 24.48 cub. m. in the second.

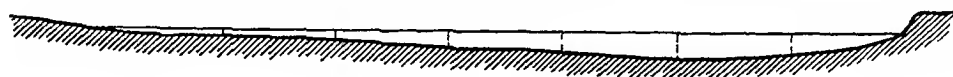


Fig. 30. Left. 0.20      0.68      1.08      1.25      1.86      1.43 = depth. Right.  
           35        65        85        83        20        42 } velocity.  
           20        52        67        63        57        42 }  
 Breadth = 52.60 m. Kijik-tele-tschöl, Sept. 29. Scale 1 : 500.

September 30th. The drop during the night was 2.1 cm. The water was transparent to a depth of 13.5 cm.\* The country was now more open and desolate; although grass and kamisch-steppe predominated. Sometimes we passed small groves of young poplars; old trees were extremely rare. Only once did we come across shepherds who owned a boat. Except for a very occasional stag, the country was destitute of game. In the district of Kenija the river flows for a long stretch due north-east. On the other side of Kona-örtäng (the Old Station — the name being possibly derived from some now abandoned route) the Jarkent-darja widens out into a well-defined channel, with containing banks 4 to 5 m. high, and a depth

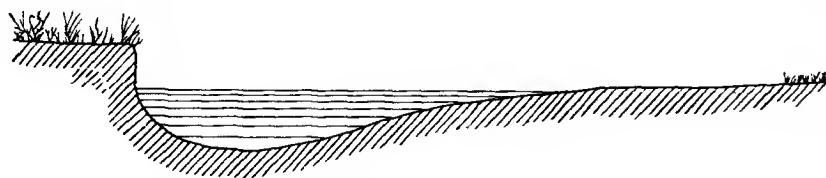


Fig. 31. TRANSVERSE SECTION OF SHARP BENDS, SEPT. 30th.

\* For determining the oscillations of level in the river I employed simultaneously two methods. First, a graduated pole was fixed in the bottom in a shaded place; and besides this a rod was thrust horizontally into the face of the scarped bank, and from its extremity was let drop an oblong metal plate, graduated to cm. and mm., with a plummet in its lower extremity.

The transparency was measured by means of a disk of white and glittering tin, taken from a cake-box. The depth was read directly from the rod which supported the disk.

which sometimes reached 8 m. At the same time the velocity was proportionally diminished. The subjoined illustration (Fig. 31) shows a transverse section of the stream at one of the sharp bends. In other places the banks on both sides are



Fig. 32. TRANSVERSE SECTION OF OPEN PART OF THE RIVER.

several score meters distant from the water's edge, and are only washed by it at the season of high flood. Below Haradighan-kötäk the river-bed is spacious and regular in outline. The breadth there was 51.00 m., the mean depth 0.620 m., the mean velocity 0.6690 m., and the volume 21.15 cub. m. in the second.



Fig. 33. Left. 0.78      0.76      0.77      0.77      0.64 = depth. Right.  
           61        84        87        77        72 } velocity.  
           61        73        79        58        67 }  
           Breadth = 51.00 m. Haradighan-kötäk, Sept. 30. Scale 1 : 500.

#### METHODS OF CALCULATING THE HYDROMETRIC DATA.

The volumetric measurements which I made in the Tarim and its branches were conducted in the following way. The first thing was to choose a suitable spot where the whole of the stream was concentrated into one channel. Then a rope was made fast to a tree on the bank, or to a stake driven into it, and stretched across the river at right angles to the current. Having ascertained the breadth, I marked it off into a given number of equal sections, indicating points of division on the rope by tying a piece of white tape round it. At each of these points the depth was sounded and the velocity measured on the surface, as well as at two or more levels intermediate between the surface and the bottom of the river, equal distances being observed between the levels. The Arwidsson's velocity-instrument which I used was made by Lyth of Stockholm. Then the number of revolutions made in a given time (generally 30 seconds) by a four-cusped propeller were read on an attached dial-plate. These observations were made from a little canvas skiff fastened at each of the tape-marks on the rope successively. The results of one series of such measurements are shown in the accompanying illustration. The top row of figures gives the depth in meters; the row immediately underneath them indicates the number of revolutions made by the propeller in 30 seconds. At the end of each series of measurements I used to make a provisional calculation of the results. The section depicted on p. 32 (Fig. 36) gave the following *data*: mean depth, 2.89 m.; average number of revolutions in 30 seconds, 36; mean velocity of

the current, 0.3348 m. in the second; volume, 29.05 cub.m. in the second. The mean velocity of the entire body of water was obtained by multiplying the mean of the velocities obtained at each sounding (that is on each perpendicular of Fig. 36) by the depth of the sounding, and then adding these products together and dividing them by the total number of soundings taken. The result so obtained was as nearly as possible the actual velocity for the given section of the river. On the other hand I committed an error in my calculation of the mean depth. The total of the depths sounded in the above example is 26.01 m.; but to divide this by the number of soundings taken (in the example 9) was an error, it should have been by the number of soundings plus 1, i. e. by 10. Hence the mean depth works out at 2.601 m.; and the volume becomes 26.124 cub.m., almost precisely the result that is obtained by Dr. Ekholm by the employment of mathematically exacter methods; for by his method I the total is 26.04 cub.m. and by his method II 26.24 cub.m., the mean between these two being 26.140 cub.m. Having thus neglected to add the corrective unit to the number of soundings, the volumes that I worked out provisionally during the course of the journey are all a little too high; these are the figures which appear in the popular description of my travels (*Central Asia and Tibet*). But, wishing to obtain the most accurate results possible from the material which I obtained with so much trouble and at the cost of so much time, I appealed to Dr. Nils Ekholm, and he has very kindly consented to recalculate my *data* according to a more strictly scientific method. All the results of volume and velocity quoted in the subjoined pages have had the advantage of his careful revision. With the view of giving the reader some idea of the materials which I collected, I have inserted in the text throughout tables of all the vertical sections measured; the top row of figures signifying in every case the depth and those which come immediately underneath them signifying the number of revolutions of the propeller in 30 seconds. The constant of the instrument is 0.279, and the number of revolutions has to be multiplied by this figure in order to obtain the number of meters in 30 seconds, and that product again must be divided by 30 to get the velocity for one second.

The illustrations themselves will show that some of the series of measurements are more trustworthy than others; the reliability increasing of course with the number of soundings taken and with the number of levels at each sounding at which the velocity was measured. In general, I may observe that the measurements are more certain as I became more accustomed to the work, and more skilled in dealing with this class of hydrographic measurement. But it is time to let Dr. Ekholm speak for himself.

# I.

Let the breadth of the river be  $b$  meter, and let this be divided into  $n$  parts  $h_1, h_2, h_3, \dots, h_n$ . Suppose that a sounding is taken and the velocity measured at each of the  $n-1$  points of division. As the velocity measurements were taken at equal vertical distances on the line of each sounding, the mean velocity of the current at every vertical line may quite simply, without any sensible error, be found by taking the arithmetical mean of all the velocity measurements in that vertical line

of sounding. Denote these successive mean velocities by  $v_1, v_2, v_3, \dots, v_{n-1}$ . Fig. 34 shows a vertical section of the river at a place of measurement. Then the vertical lines  $N_1O_1, N_2O_2, \dots, N_{n-1}O_{n-1}$  indicate the lines of sounding, and the dotted lines  $M_1P_1, M_2P_2, \dots, M_{n-2}O_{n-2}$  bisect the distances between them. The

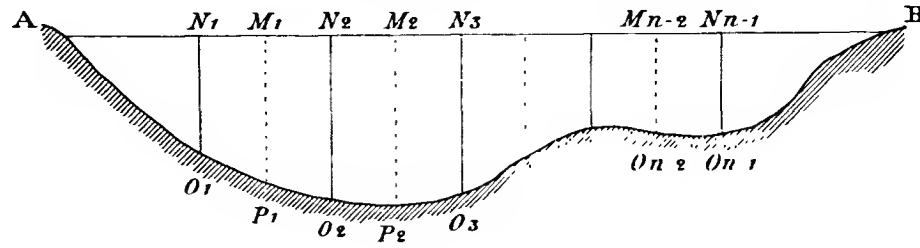


Fig. 34.

most accurate way to ascertain the volume of the water flowing past the section in the unit of time is to measure with the planimeter the areas of the figures  $AM_1P_1, M_1M_2P_2P_1, \dots$  and to multiply the successive areas by their corresponding mean velocities and take the sum of the products. Thus, if we denote the areas by  $a_1, a_2, a_3, \dots, a_{n-1}$ , then the volume  $Q$  which passes the section in the unit of time is

$$Q = a_1v_1 + a_2v_2 + \dots + a_{n-1}v_{n-1} = \sum av \dots \dots \dots (1)$$

The mean depth is

$$d_m = \frac{A}{b} \dots \dots \dots (2)$$

where

$$A = a_1 + a_2 + \dots + a_n = \sum a \dots \dots \dots (3)$$

$A$  denoting the area of the total section of the river.

The mean velocity of the entire river is

$$V_m = \frac{\sum av}{\sum a} = \frac{Q}{A} \dots \dots \dots (4)$$

As a check upon this,  $Q$  may be calculated from the formula

$$Q = bd_mV_m \dots \dots \dots (5)$$

## II.

The following simplified method may also be employed, without any material error, more especially as the contours of the river-bottom between the vertical soundings are not known.

In fig. 35 we bisect each of the  $n$  divisions  $AN_1, N_1N_2, \dots, N_{n-1}B$ , and from the points of bisection  $Q_1, Q_2, \dots, Q_n$  let drop the perpendiculars  $Q_1R_1, Q_2R_2, \dots, Q_nR_n$ ; then through the lower ends  $O_1, O_2, \dots, O_{n-1}$  of the lines of sounding draw the horizontal lines  $R_1R_2, S_2R_3, \dots, S_{n-1}R_n$ . Then the area of the figure bounded by the broken line  $Q_1R_1R_2S_2R_3S_3 \dots S_{n-1}R_nQ_n$  and the straight line  $Q_1Q_n$  is approximately equal to the area of the vertical section of the river; and the difference diminishes without limit, as the number of points  $N_1, N_2, \dots, N_{n-1}$

increases. Then, denoting the vertical lines  $N_1O_1$ ,  $N_2O_2$ , . . . .  $N_{n-1}O_{n-1}$  by  $p_1$ ,  $p_2$ , . . . .  $p_{n-1}$ , we readily obtain

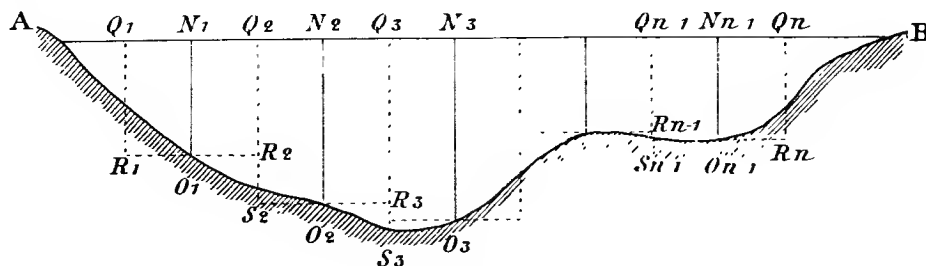


Fig. 35.

$$Q = v_1 p_1 \frac{h_1 + h_2}{2} + v_2 p_2 \frac{h_2 + h_3}{2} + \dots + v_{n-1} p_{n-1} \frac{h_{n-1} + h_n}{2} \dots \dots \dots (6)$$

and

$$A = p_1 \frac{h_1 + h_2}{2} + p_2 \frac{h_2 + h_3}{2} + \dots + p_{n-1} \frac{h_{n-1} + h_n}{2} \dots \dots \dots (7)$$

From (6) and (7), by means of equations (2) and (4), we are able to obtain the values of  $d_m$  and  $V_m$ . If the  $n$  divisions are all equal, i. e.

$$h_1 = h_2 = \dots = h_n = h \quad \text{and} \quad b = nh,$$

the formulæ (6), (7), (2), and (4) become simplified thus

$$Q = h(v_1 p_1 + v_2 p_2 + \dots + v_{n-1} p_{n-1}) = h \Sigma v p \dots \dots \dots (8)$$

$$A = h(p_1 + p_2 + \dots + p_{n-1}) = h \Sigma p \dots \dots \dots (9)$$

$$V_m = \frac{\Sigma v p}{\Sigma p} \dots \dots \dots (10)$$

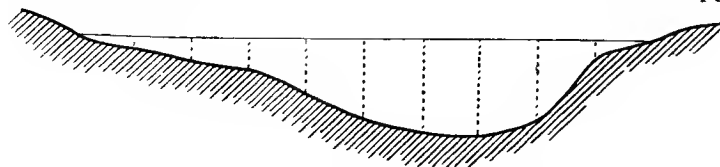
$$d_m = \frac{\Sigma p}{n} \dots \dots \dots (11)$$

Formula (5) may be employed as a check upon this. Throughout the whole series of measurements the length of  $b$  has been divided into equal distances.

### III.

In order to show the use of the simplified method worked out in II, we will now calculate the volume of the river, according to both methods, using the data afforded by four actual measurements. The constant  $k$  of the velocity instrument is 0.00930; multiplying by this coefficient, we reduce the values given here below for  $v/k$ , which indicate the number of revolutions in 30 seconds, to metres per second.

Fig. 36. Left. 10 April 1900.  $b = 30.0$  metres.  $n = 10$  Kum-tschapghan. Right.

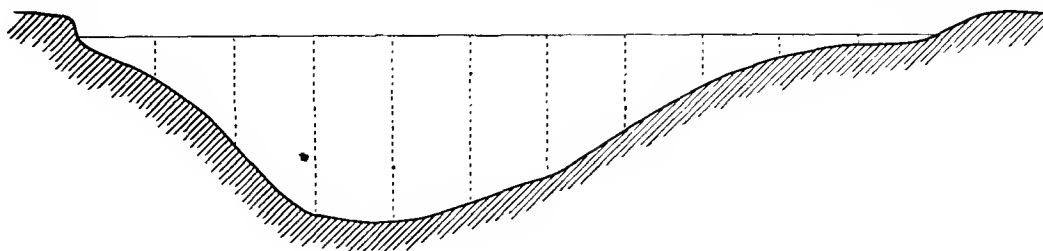


$p$	. .	0.68	1.18	1.67	2.96	4.30	4.93	5.09	4.33	0.87	metres
$v/k$	. .	21.5	31.5	33.7	39.0	45.0	38.4	43.2	26.4	0	$\frac{1}{k}$ metre second

We get by numerical calculation

	$Q$	$A$	$d_m$	$V_m$
according to method I . . . . .	26.04 $\frac{\text{m}^3}{\text{sec.}}$	78.15 $\text{m}^2$	2.605 m	0.3332 $\frac{\text{m}}{\text{sec.}}$
according to method II . . . . .	26.24 $\frac{\text{m}^3}{\text{sec.}}$	78.03 $\text{m}^2$	2.601 m	0.3363 $\frac{\text{m}}{\text{sec.}}$

Fig. 37. Left. 10 April 1900.  $b = 22.0$  metres.  $n = 11$  Tusun-tschapghan. Right.

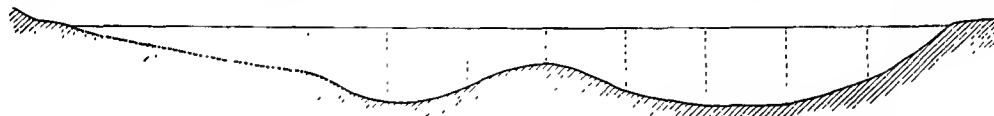


$p$ . .	1.06	2.87	4.67	4.80	4.36	3.75	2.41	1.30	0.62	0.16	metres
$v/k$ . .	35.0	52.0	45.25	41.0	40.0	37.2	30.3	34.5	18.5	28	$\frac{1}{k} \frac{\text{metre}}{\text{second}}$

The results obtained are

	$Q$	$A$	$d_m$	$V_m$
according to method I . . . . .	19.51 $\frac{\text{m}^3}{\text{sec.}}$	52.60 $\text{m}^2$	2.391 m	0.3709 $\frac{\text{m}}{\text{sec.}}$
according to method II . . . . .	19.39 $\frac{\text{m}^3}{\text{sec.}}$	52.00 $\text{m}^2$	2.364 m	0.3728 $\frac{\text{m}}{\text{sec.}}$

Fig. 38. Left. 10 April 1900.  $b = 22.6$  metres.  $n = 11$  Kum-tschapghan. Right.

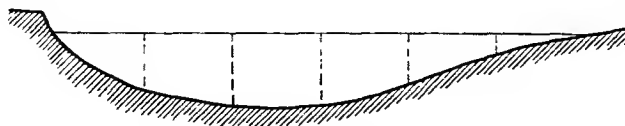


$p$ . .	0.46	0.88	1.16	1.88	1.48	0.86	1.63	1.99	1.96	1.37	metres
$v/k$ . .	2.0	3.0	8.0	28.7	26.3	19.5	41.7	47.0	52.3	45.7	$\frac{\text{metre}}{\text{second}}$

Here the results are

	$Q$	$A$	$d_m$	$V_m$
according to method I . . . . .	8.52 $\frac{\text{m}^3}{\text{sec.}}$	27.86 $\text{m}^2$	1.233 m	0.3058 $\frac{\text{m}}{\text{sec.}}$
according to method II . . . . .	8.58 $\frac{\text{m}^3}{\text{sec.}}$	28.09 $\text{m}^2$	1.243 m	0.3055 $\frac{\text{m}}{\text{sec.}}$

Fig. 39. Left. 22 Sept. 1899.  $b = 35.3$  metres.  $n = 6$  Schakal-otak. Right.



$p$ . . . . .	3.72	4.98	4.77	3.09	1.23	metres
$v/k$ . . . . .	83.0	78.5	71.0	53.5	4.5	$\frac{1}{k} \frac{\text{metre}}{\text{second}}$

And the results work out thus

	$Q$	$A$	$d_m$	$V_m$
according to method I . . . . .	68.30 $\frac{\text{m}^3}{\text{sec.}}$	109.03 $\text{m}^2$	3.089 m	0.6264 $\frac{\text{m}}{\text{sec.}}$
according to method II . . . . .	66.16 $\frac{\text{m}^3}{\text{sec.}}$	104.66 $\text{m}^2$	2.965 m	0.6321 $\frac{\text{m}}{\text{sec.}}$

In employing method I the sections were plotted on a very large scale on cross-ruled paper and the curves of the river-bottom put in by hand; then the areas were measured by a polar planimeter, made by F. J. Berg of Stockholm, and belonging to the Mechanical Institute of the University of Stockholm.

As will be seen, there is a very close agreement between the results obtained by the two methods in the first three out of our four examples, in which the soundings occur close together; and in the fourth case, in which the distances between the soundings are greater, the agreement may be pronounced satisfactory. Whence we conclude, that the simpler method II is sufficiently exact for all cases.

*Dr. Nils Ekholm.*

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## CHAPTER III.

### FROM KURUK-ASTI TO THE CONFLUENCE OF THE KODAJ-DARJA.

October 1st. Drop, 1.7 cm.; transparency 13.7 cm. Along the stretch traversed to-day the river was shallower and more rapid, was inclosed between scarped banks 3 m. high, and was sometimes 20 m. broad, without a trace of alluvial formation. The steppe was now universal, bushes being rare, as were also the poplars. The principal names in the local topography were Schorluk-utak and Kum-tschakil. In one place we observed three permanently occupied huts, and at Kuruk-asti four more, all in better condition than usual. At the latter place the river deviates to the south-east, so as to avoid the isolated mountain of Hasret-Ali-masar. Immediately above this point the Jarkent-darja is joined by two natural canals, both deeply and sharply trenched, which contributed to it a considerable volume of water from the adjacent lake of Schor-köl. Close to their mouths they broke over small foaming cascades; but their water was decidedly limpid as compared with the turbid aspect of the main stream.

Immediately north of the river stands the small isolated mountain of the Masar-tagh, which I visited in 1895, and which is known locally under the name I have quoted above, namely Hasret-Ali-masar. A fresh visit which I now paid to it enabled me to complete my map, as well as afforded me an opportunity to study the relations of the river to the mountains in the same neighbourhood. The southern extremity of the Masar-tagh is crowned by the little *guristan*, or 'burial-place', from which the name Hasret-Ali-masar is derived. It lay  $\frac{1}{2}$  km. north-north-east of our camp at Kuruk-asti. Two minor ramifications of the mountain advance close to the edge of the arm of the river called Kodaj-darja, and between them stands a flourishing grove of poplars. Here too were burial-places with their *gumbes*, or sepulchral chapels, two or three of them just beginning to fall into decay. On the nearer side the Masar-tagh is built up of two different formations — one an exceptionally fine-grained rock, laminated and foliated, and with a dip of  $9^{\circ}$  N.N.W. — the other consisting of veins and dykes of a dark green porphyry, ramifying in many directions through the former rock. Owing to its relatively greater hardness, the porphyry stands out on the face of the mountain in strong relief, in the shape of knobs and knife-back edges, giving it a striated appearance when seen at



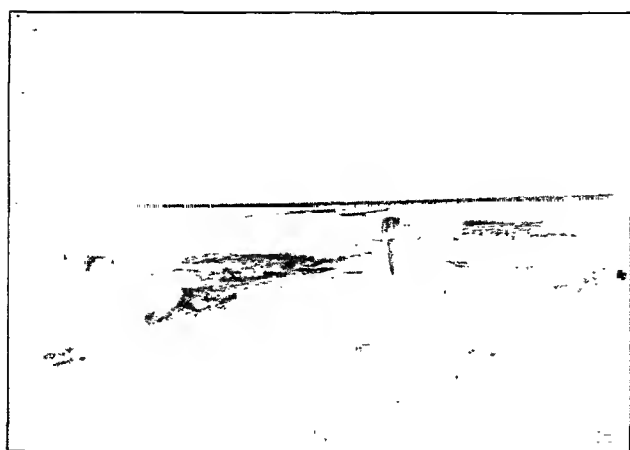
*Lynstr. A. B. Lagrelius & Westphal.*

VIEW LOOKING N.N.W. FROM KURUK-ASTI.

The Masan-tagh in the background.



a distance, especially as the veins and dykes run from the N.N.W. to the S.S.E., and have a dip of  $83^{\circ}$  towards the E.S.E. In some places the porphyry is cracked and arranged in rectangular blocks, like the masonry of cyclopean walls, and between it are packed, in parallel layers, the laminæ of the other formation, disposed with a regularity which suggests the work of human hands. Although both rocks are hard, they are nevertheless both severely weathered.



Figs. 40—43. DIFFERENT POSITIONS FOR FISHING IN THE CATARACTS OF THE BIG CANAL FROM SCHOR-KÖL.

A survey of this locality from a commanding vantage-point showed that the steppe was almost universally prevalent in every direction; bushes and isolated poplars were extremely rare. In the direction N.  $60^{\circ}$  W. lay a network of lakes, some large, some small, but all shallow and marshy, and diversified by a number of little bays, isthmuses, and islands. These were connected with the Jarkent-darja by the two natural canals mentioned above. The two largest lakes bear the names of Schor-köl and Anar-köl. The former name means 'salt lake'; but its water was of course fresh, although I was told that at the period of low water, some of the disconnected pools

into which it then breaks up become slightly saline. The name Anar-köl was probably bestowed because of the resemblance which the arrangement of the little lakelets that constitute it bears to the disposition of the seeds inside a pomegranate (*anar*). To the south-east rises the Southern Masar-tagh, and in the south-south-east the high sand-dunes of the desert, known here also as the Takla-makan.

At Kuruk-asti the Jarkent-darja divides into two arms. The one to the north, called the Kodaj-darja, or Swan River, bathes the southern foot of the Masar-tagh; though at the time of our visit it only contained a few pools of stagnant water. Ten days previously, or about the 20th September, the river had ceased to enter that watercourse and directed itself entirely into the southern arm. Yet for fully two months, counting from the 1st July, the Kodaj-darja had been a running stream, though with a far less volume of water than the Jarkent-darja. Lower down the Kodaj-darja is joined by the Kaschgar-darja, and then, as we shall presently see, the united stream reenters the Jarkent-darja, but beyond Avat. The following places, all situated on the great caravan route from Maral-baschi to Ak-su, draw their irrigation water from the river I am discussing, namely the Kodaj-darja, — Masar-aldi, Tschahr-bagh, Tschighan-tschöl, Tumschuk, Tschadir-köl, Jar-kuduk, and Suget. As all the places just mentioned are entirely dependent upon the Kodaj-darja for the fertility of their fields and gardens, it was a serious matter for them when the current entirely abandoned that arm and began to flow through the southern arm only. Since that fatality happened, the several villages named have been restricted for their necessary supplies of water to wells and *köl's*, or artificially dug reservoirs. Their chief concern was in the autumn to redivert the river into the bed of the Kodaj-darja, a project which the people purposed to carry out a month later by building a dam across the bed of the Jarkent-darja. For this object they had already brought over about a thousand poplars from the nearest forest. It was however somewhat doubtful whether, owing to the power of the current, their efforts would be crowned with success. Changes in the bed of a river of that magnitude, brought about by physical laws, cannot be permanently controlled by such dams as these people are able to construct.

Of the two natural canals which connect Schor-köl with the Jarkent-darja at Kuruk-asti, the more easterly one issues from the lake by three arms; and of these three arms, again, the one that lies farthest to the east plunges down a cascade 1.5 m. high. The boiling cauldron at its foot affords excellent fishing. The apparatus used consists of a rod (*sap*) resembling an eel-spear, with two hooks (*satschkak*), each pointing downwards, fixed in its lower end. The hook, upon striking the fish, becomes detached from the rod or shaft, and is then only held fast to it by a cord 50 cm. long. Below this cascade the surface of the stream was 2 to 2½ m. lower than the level of the adjacent country. Schor-köl is, properly speaking, a marsh; and its shores are soft and boggy, and overgrown with luxuriant grass and reeds, the latter even invading the lake itself. Beside the western of the two principal arms which drain it stood a shepherd's hut (*satma*), inhabited by a single family, who in addition to tending their sheep, also had some cattle to look after. These were however their summer quarters only; in winter they usually occupy a more substantial dwelling on the right bank of the Jarkent-darja.

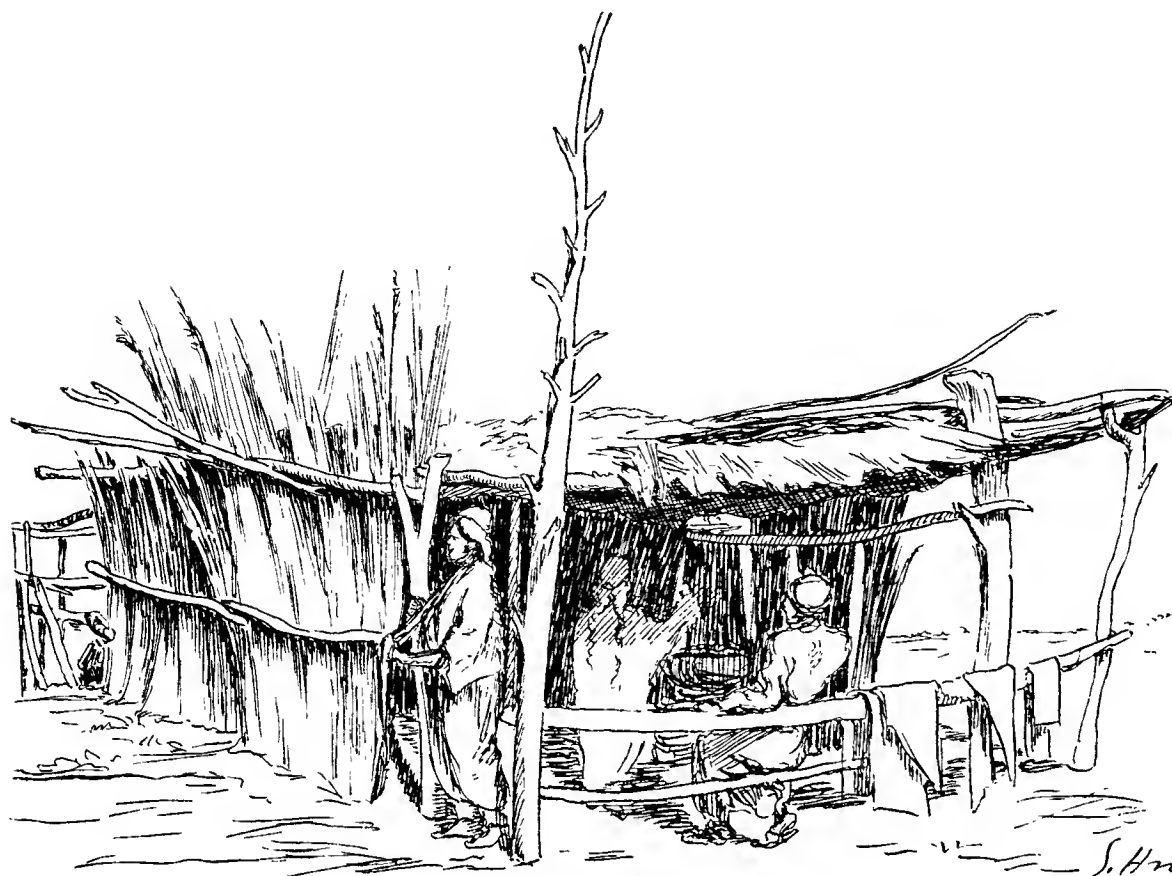


Fig. 44. SHEPHERD'S HUT NEAR SCHÖR-KÖL.

With regard to the two natural canals, on 3rd October the breadth, mean depth, mean velocity per second, and volume per second in the three branches of the eastern canal were respectively — (1) 3.40 m., 0.77 m., 1.21 m., and 3.17 cub. m.; (2) 4.40 m., 0.74 m., 1.25 m., and 4.35 cub. m.; (3) 1.56 m., 0.56 m., 0.83 m., and 0.73 cub. m.; and in the western canal (4) 2.35 m., 0.79 m., 1.18 m., and 2.2 cub. m. Thus the total volume amounted to 10.45 cub. m. in the second. Now besides these two canals the river was evidently joined above Kuruk-asti by several other contributaries from the Schor-köl; but owing to their being so effectually masked by the reeds and bushes, they had escaped my observation. At least I am led to infer there were such from the results of the measurements which I obtained at Kuruk-asti on 2nd October, when the volume was 45.41 cub. m. (the breadth being 52 m., the mean depth 1.400 m., and the mean velocity 0.6238 m. per second), whereas the immediately preceding measurement, made on 30th September, had given a volume of only 21.15 cub. m.



Fig. 45. Left. 2.20      2.71      1.29      0.80 = depth. Right.  
           72         54         54         59 } velocity.  
           71         86         69         49 }  
 Breadth = 52.00 m. Kuruk-asti, October 2. Scale 1 : 500.

After my previous visit in 1895 I had erroneously assumed, that the Schor-köl was a marginal lagoon of the Kodaj-darja.\* And even now I confess I do not possess a sufficiently accurate knowledge of it to determine with certainty whence it derives its water. The only source which I can conceive it to draw upon is the Kona-darja, the old channel of the Jarkent-darja, from which the canals of Maral-baschi are fed. There can scarcely be a doubt, but that the surplus water, which at the season of high flood enters that old channel, does eventually find its way into the Schor-köl, and the other small lakes in the vicinity; for at the season of high flood those lakes are said to merge into one large connected sheet of water and even in the autumn they contribute, as we have seen, a considerable increment to the Jarkent-darja. Any way the overflow of the high-flood season cannot advance farther east than Kuruk-asti, owing to the fact that its further progress is barred by the barrier of the Masar-tagh, which forces it back into the river. The cascades owe their origin to the fact that the level of the lake is about 1.5 m. higher than the level of the river. But in this district, as indeed everywhere else along the course of the Jarkent-darja and the Tarim, the hydrographical relations are subject to great and frequent changes.

Intermediate between the two canals which drain the Schor-köl, the Jarkent-darja is also joined by yet another old channel, a branch of itself, which has only ceased to carry water since it was stopped up in the year 1895. It was, however, so faint that its course did not admit of being fully traced. The dam by which it was closed still remained unimpaired. It was said to have been built for the purpose

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\* General Pjevtsoff visited this region in 1889, and what he says about it goes a long way towards throwing light upon its complicated hydrographical relations. South of Tschadir-köl and Tumschuk he discovered an extensive marsh, known as Lalmoj, and mapped its south-east border. He says, 'This marsh is oval in shape, and extends from the north-east to the south-west, being 60 versts long by 12 versts wide. It is thickly covered with reeds, reaching in some places a height of 3 saschen [1 saschen = 2.1335 m.]. An arm of the Jarkent-darja, called Ugusilde, slowly makes its way through the marsh, and then, breaking up into a multitude of little arteries, forms a perfect labyrinth of small salt lakes, with two others of considerable size beside them. The thick, tall reeds round the marsh of Lalmoj harbour tigers and a great number of wild-boar, while multitudes of birds, both waders and swimmers, nest all round the lakes.'

Pjevtsoff then goes on to say, that the marsh was encircled by a large number of fresh-water lakes, these being especially numerous at its south-west corner, and that the 'arm of the Jarkent-darja', which evidently was none other than the Kodaj-darja, lost itself amongst them. All these sheets of water expand and become full at the season of high flood, which according to Pjevtsoff, occurs between 15th June and 15th July (O. S.). He continues, 'After travelling 6 versts next day along the south-eastern shore of the marsh, we turned towards the west, and on narrow bridges crossed the seven broad and deep canals, which the natives have led off from the dammed-up arm of the Jarkent-darja, that is to say, the arm which feeds the marsh of Lalmoj.'

According to Pjevtsoff, the Kaschgar-darja also loses itself in an extensive marsh, lying 30 versts east of Maral-baschi and near the village of Tschahr-bagh. This marsh gradually narrowed south-eastwards to a thin strip, without however reaching all the way to the swamp of Lalmoj. From the extremity of the former marsh there likewise issued a stream, which emptied itself into the lake beside which we encamped. It is in this way at all events, that the water of the Kaschgar-darja, though only a relatively small proportion of it, does eventually reach the Jarkent-darja. Hence in 1889 the confluence of the two rivers was in point of fact at Lalmoj. Since then, as we have found, the Kodaj-darja has broken away from them, and is now endeavouring to pass to the north of the marshy region. Thus there can be no doubt that, since the date of Pjevtsoff's visit, the marsh of Lalmoj has essentially shrunk in area; although it still remains one of the marginal lagoons which, like vampires, suck the blood out of the main stream. When a marsh of this character disappears it obviously means a relative augmentation in the Jarkent-darja. See M. V. Pjevtsoff, in *Trudij Tibetskoj Ekspeditsij*, 1889—1890, vol. i. pp. 66 ff.

Pl. 7.



*Lynstr. A. B. Lagrelius & Westphal.*

VIEW LOOKING S. FROM THE BURIAL-PLACE ON THE NORTHERNMOST PART OF THE SAJ-TAGIL.

The Right Bank of the River (not visible) is close to the Right of the Photograph





of preventing the Kodaj-darja from being robbed of its current. The portion of the bed of this old watercourse which lay below the dam was  $1\frac{1}{2}$  meter lower than the portion above it, that is to say, to the north of it. There was bright stagnant water on both sides of the dam, but the end of the channel next the river was perfectly dry. At the time this channel was stopped; the river divided again, as we have stated, at Kuruk-asti, so that, to retain the water in the Kodaj-darja, a fresh dam had to be put in there also.

The former dam (*togh*) was 32 m. long, and thus stretched transversely across the bed of the river, and was 12.30 m. broad. It consisted of four rows of piles, driven vertically into the bottom of the river, the two outermost rows being 12.30 m. apart, and the two innermost 10.10 m. apart, while the individual piles were driven at a distance of  $\frac{1}{2}$  m. from one another. The spaces between the rows of piles (*a* in cut) were rammed with branches and brush-wood, and the middle space (*b*) was filled with clay and earth. The top of the dam was barely more than one meter above the existing level of the river. This is the method of construction generally adopted for dams in East Turkestan; and from their temporary character it is evident, that they are unable to offer any serious resistance to the pressure of large volumes of water. Since the Jarkent-darja deserted the old bed between the canals, the dam there has lost all importance.

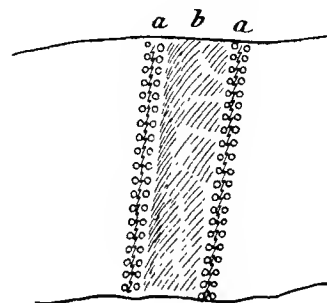


Fig. 46. DAM IN AN OLD RIVER-BED.

October 4th. Between 2 o'clock in the afternoon of the 2nd and 7 o'clock on the morning of the 4th the river dropped 3.9 cm. At Kara-tokaj (Black Young Forest) the river is joined from the right by another Kona-darja, which was abandoned, I was told, fourteen years before, and since then has been dry.

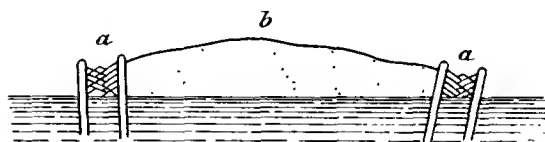


Fig. 47. DAM IN AN OLD RIVER-BED.

It issues from the main stream a little way below Schamal. This Kona-darja probably used to unite with the Kodaj-darja, for the arm of the Jarkent-darja which we were navigating was quite new. The district on the opposite bank is called Jigde-örtäng. The river here flows towards the east-south-east, and is sometimes straight, sometimes sinuous. For long distances it maintains the same uniform breadth of 50 to 60 meters, and is inclosed between tolerably high banks, overgrown with kamisch and underwood, and very often beset with dense thickets. In fact, it resembles generally an artificial canal, with regularly rounded curves and for the most part no traces of alluvial deposits. The depth was considerable, and the current sluggish. The transparency of the water was 30 cm., a consequence of the copious contributions made by the canals from the Schor-köl, the reedy basins of which act as settling beds for the sedimentary matter held in suspension by the current.

At Ak-jasik and Älgäkschi the river makes a sharp bend to the north. Shepherds' huts made their appearance at intervals. Further on we passed the districts of Häser and Jigde-jasuk. A little below the latter two canals are led off from the river to the right, that is to the south, one of which was dry, while the other

contained water. But they soon unite, and then proceed to the lake of Jughan-balik-köl, situated at the northern foot of the Tusluk-tagh, where I made a halt in 1895. Thence the water makes its way into the Sorun-köl, and finally terminates in the Tschöl-köl, situated at the west side of the detached mountain which I discovered in 1895 and which, as my guide was unable to give it a name, I called the Southern Masar-tagh; though I now know that its real name is the Tschoka-tagh. North-west of the Tusluk-tagh there stands another little detached mountain known as Jul-annam. On the south the Tschöl-köl is bordered by the great »ocean of sand«, which the shepherds of that neighbourhood call Ak-kum (White Sand), Schahr-i-katak-kum (from a legendary town which is reputed to lie buried under the sand), or Takkan, plainly an abbreviation of Takla-makan. My renewed investigations of the locality enabled me to add materially to my former map, and showed me, that the Jarkent-darja flows almost immediately along the northern foot of these mountains. As the river swells to its full flood, these canals and lakes gradually fill, and when it drops, they return a portion of their water to its bed. The residue that remains in them through the winter soon gets cut off from the river, and freezes. As the name indicates, Jughan-balik (the Big Fish) is well stocked with fish, which are taken by the inhabitants of Tschahr-bagh and Masar-aldi, from canoes hollowed out of the stems of poplars. The fishing seasons are in spring and summer. In the Tusluk-tagh there is a deposit of salt, which is mined in winter when the river is frozen, that being the only time at which the people can get their carts (*arbas*) across the stream. Beside our camp at Jughan-balik dwelt three shepherds and their families, in charge of about 1000 sheep, belonging to *bajs* or »rich men« in Tschahr-bagh and Masar-aldi. Here, as everywhere else along the river, the sheep are shorn twice in the year, first in the spring, and again in the autumn, and at those seasons the owners of the flocks come and fetch the wool. In this locality tigers had recently paid several visits, and during the year had already carried off five horses and a number of sheep.

I was told by these shepherds, and their information was corroborated by a hunter whose pursuit takes him into all parts of that region, that a long day's journey east of the Tschoka-tagh, and a short day's march south of the river, there exists an old river-bed stretching from west to east, and known as the Kara-saj. The surface of the country through which it runs consists, they said, of gravel and coarse sand, resting upon yellow earth and salt, with small fragments of flint embedded in it. Some of these last were given to me in proof of the statement. On the east, south, and west the Kara-saj is shut in by dunes of drift-sand. Defective though this information is, I nevertheless record it here; even these cursory indications might possibly prove important in future exploratory work. But the place as described to me seems to suggest not so much an old river-bed as a portion of the desert off which the drift-sand has been swept, exposing the surface underneath. At all events, I came across similar tracts whilst crossing the Takla-makan in 1895. The country which extends between the Kara-saj and the river is reported to be full of dead forest (*kötäk*), with a few living poplars at wide intervals apart.

October 5th. From 9 o'clock in the afternoon to 7 o'clock on the following morning the river dropped 1.3 cm. Thus the subsidence proceeds pretty uniformly



*Lustr. A. B. Lagretius & Westphal.*

VIEW LOOKING N. FROM THE SAME POINT AS IN PL. 7.

In the Foreground Graves, in the Background Sultan Kara Sakal Atam, in the Middle the Northernmost Part of the Tschokactagh (Saj-tagh).



in the autumn. The transparency reading was 24 cm. During the day the river meandered a great deal, but nevertheless maintained a good rate of flow. The banks were lined by thin, narrow belts of young forest, intermingled with bushes; except for these, there was nothing but kamisch steppe as far as one could see. The general name of the district is Jughan-balik-tallik. Although in two or three places small branches broke away from the river, they soon rejoined it again. The atmosphere was nearly always more or less impregnated with dust, through which we obtained from time to time glimpses of the small mountains, remnants of a range long since broken down, which lie scattered over the face of the country, e. g. the Tschoka-tagh, with the Sorun-köl in the foreground; the Tusluk-tagh, with the Jughan-balik at its foot; Jul-annam; and Hasret Ali (Masar-tagh). Besides these, I was informed there are minor isolated mountains in the same quarter, bearing the names of Teven-tagh, Kallap-tagh, and Sultan Kara Sakal Attam. Of the last-named we caught a faint glimpse to the north-east.

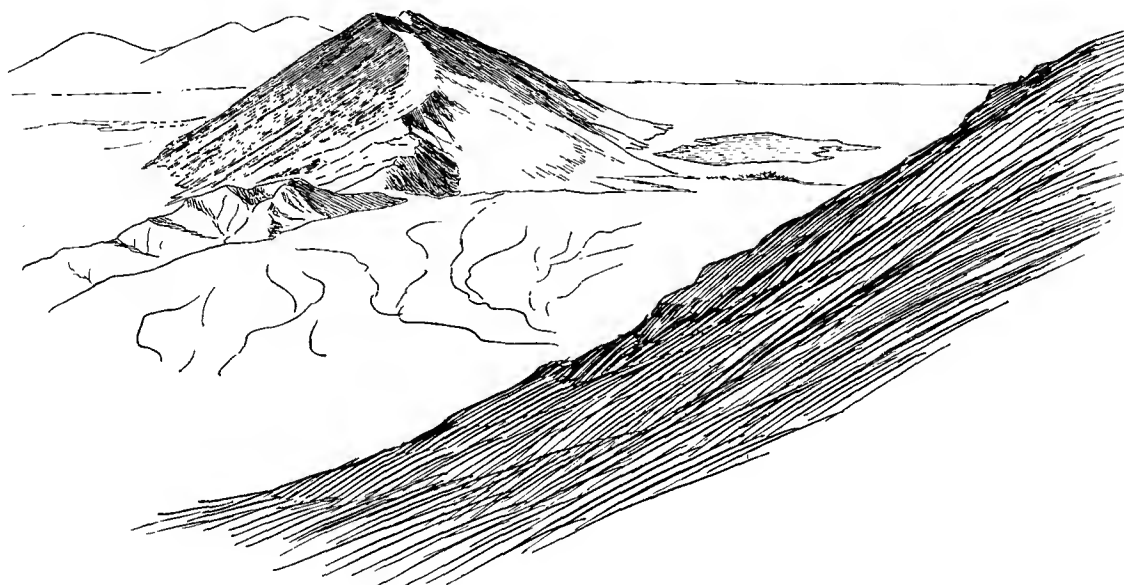


Fig. 48. SAJ-TAGH AND SAJ-KÖL AS SEEN FROM THE NORTHERNMOST PART OF TSCHOKA-TAGH.

The place at which I now measured the river was off the end of a canal which connects it with the Sorun-köl, and where four huts stood. Here the breadth was as much as 53.18 m., the mean depth, 1.297 m.; the mean velocity, 0.3499 m.; and the volume, 24.13 cub. m. in the second. Thus the increments which were added by the canals of Kuruk-asti had by this disappeared, having partly been drained off by other canals to the Jughan-balik-köl, and partly the loss was accounted for by the steady fall in the river itself.

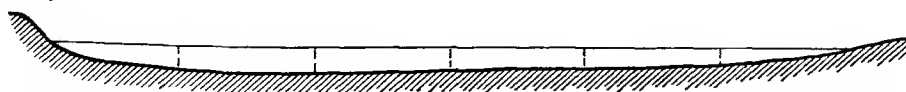


Fig. 49. Right. 1.62      1.86      1.71      1.41      1.18 = depth. Left.  
 42      45      48      41      28 } velocity.  
 33      39      37      29      26 }  
 Breadth = 53.18 m. Sorun, October 5th. Scale 1 : 500.

*Hedin, Journey in Central Asia.*

October 6th. The transparency of the water = 30.5 cm. To reach the Tschokatagh on foot, it was necessary to walk round the eastern shore of the Sorun-köl, owing to this lake being connected with the river by two shallow channels. Through these, at the season of high flood, the water flows into the lakes, as indeed it does through the other canals I have mentioned; but as soon as the river drops below the level of the lakes, the water returns again to the former, using the selfsame channels. But besides the Sorun-köl there is also the Tschöl-köl to be filled, and as it is devoid of vegetation, a very appreciable evaporation takes place over its surface; so that here again heavy tribute is levied upon the long-suffering Jarkent-darja.



Fig. 50. SAJ-TAGH. TO THE LEFT A PART OF SULTAN KARA SAKAL ATTAM; TO THE RIGHT SAJ-KÖL.

The line of demarcation between the marshy shores of the Sorun-köl and the gravelly scree of the Tschokatagh is very sharply drawn. From a commanding point of this mountain we obtained a view of the top of the Saj-tagh to the north-east. Its southern flank was covered with rounded sand-dunes. On its north-west side the rock-formation was exposed, and below it lay the farthest arm of the lake, encircled by a thin belt of poplars, bushes, and plant-grown sand-dunes. At the south-east foot of the Saj-tagh nestles the little lake of Saj-köl, fed by natural springs, derived probably from the river, and girdled by a deposit of white crystalline salt. Except for a clump of poplars on its southern shore, the little lake is surrounded on all sides by steppe, though the desert of drift-sand, the same in which my caravan was lost in 1895, approaches to within one kilometer of it on the east. The precipitation which falls on the slopes of the adjacent mountains is carried off by a little stream that flows into the lake. Considering the extreme paucity of the rain-fall, and the insignificant amount of the snow — for snow does fall here some winters — it was surprising to see how sharply and deeply these rivulets had cut into the rock. And the same phenomenon was repeated again in that part of the Tschoka-



*Linst. A. B. Lagardus & Westphal.*

VIEW TO THE S.W. FROM THE SAME POINT AS IN PL. 7 AND PL. 8.

To the Left Sog-tagh, behind it a small Portion of the Tschokatagh; to the Right in the Background the Tschokatagh.





tagh which lay nearest to us, that is in the short spurs which that mountain sends out towards the north-west. There however the natural watercourses are not only deeply grooved, but they terminate in spreading gravel screes, which, from the network of rivulets into which each watercourse divides and subdivides, appear like miniature deltas thrust out into the lake below. Except for these, the shore-line of the Saj-tagh is on that side tolerably regular in formation, therein presenting a marked contrast to the broken and ragged outlines of its north-western shore. The lake contains several expanses of open water, separated or united by necks of land, sounds or channels, and beds of kamisch, and dotted over with islands. Along its northern shore lay a vast number of tiny lakelets, all more or less connected together by marshes or open belts of water.

The principal basin of the Sorun-köl extends between the northernmost projections of the Tusluk-tagh and the Tschoka-tagh, and in that way it escaped my observation in 1895. This part of the lake was less smothered in reeds than the Sorun-ajaghi-köl, or Lower Lake Sorun, which I shall proceed to describe presently. One of the little lakes at the northern foot of the Tusluk-tagh is called the Häser-köl, and has poplars of a tolerably tender age growing thinly round its shores. On that side the Tschoka-tagh is built up of the same fine-grained, severely weathered rock which I have described as occurring in the Masar-tagh. The dip of the strata was  $27^{\circ}$  to the N.  $40^{\circ}$  E.

On October 7th I explored the Sorun-köl by boat. The lake stretches from north to south. Its water was perfectly limpid and fresh, and at 11 a. m. had a temperature of  $13.7^{\circ}$  C. Algæ grow in vast quantities along its bottom; and belts of reeds, often very thick, run all round its shores, as well as dot its surface in island-like beds. The reeds on the western shore conceal numerous channels, which connect with the smaller lakes in that direction. Amongst these same lakes are a few sand-dunes, dotted with tamarisks; but they must be older than the lakes, otherwise in this marshy region the sand would have been unable to pack itself up into dunes. Along the lake's eastern shore the naked earth peeps out at intervals at the foot of the gravel screes. Towards the south the lake widens, as I have already said, into a broad basin, which was quite free of reeds, except for a narrow ribbon round its shores. The maximum depth did not exceed 1.99 m. The measurements which I obtained along a line drawn from north to south were as follows: — 0.80, 0.84, 1.22, 1.29, 0.81, 1.01, 1.06, 1.14, 1.24, 1.61, 1.53, 1.51, 1.52, 1.59, 1.34, 1.21, 1.00, 1.01, 1.31, 1.69, 1.85, 1.90, 1.99, 1.89, 1.88, 1.73, 1.75 m. This proves that the Sorun-köl, after all, is nothing more than a shallow, marshy sheet of water. On the other hand, in the channel which connects the Sorun-köl with the Tschöl-köl I obtained depths of 3.35, 2.00, 2.10, 3.65, and 2.10 m. At first this connecting passage was almost completely choked with reeds; but soon we came into open water 2 to 3 m. broad, and finally emerged into a waterway which reached a breadth of 30 to 50 m., there being only one or two points at which it contracted to 10 m. The ground through which it has cut its way is hard and consistent, although obscured by reeds; so that for the most part this watercourse exhibits all the regularity of an artificial canal. And yet it is kept open by nothing but the natural current flowing backwards and forwards between the Sorun-köl and the Tschöl-köl; though, owing to its en-

hanced power of erosion, a consequence of its being confined to such a narrow passage, its depth exceeded the depth in the adjacent parts of the two lakes which it connects. It is through this channel that the more southerly lake of Tschöl-köl becomes filled every summer; and at that season there is always a steady, though at the same time gentle, current flowing into it, caused by the rapid evaporation which takes place over its open surface. When, however, the Jarkent-darja drops in the autumn, the current turns and flows back towards the north. Yet, by reason of the shallowness of the watercourses which unite the Sorun-köl with the river, neither that lake, nor, consequently, the Tschöl-köl, can be entirely emptied. In the beginning of October, at the time of our visit, their surface was however very



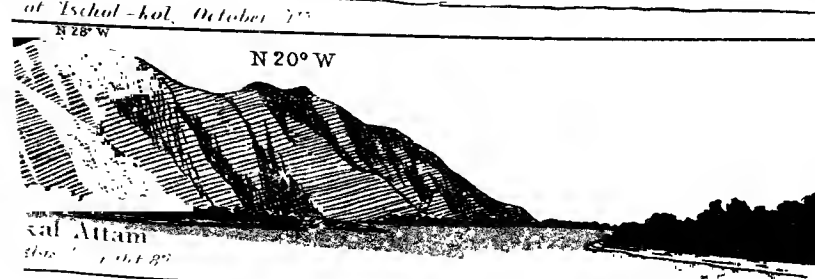
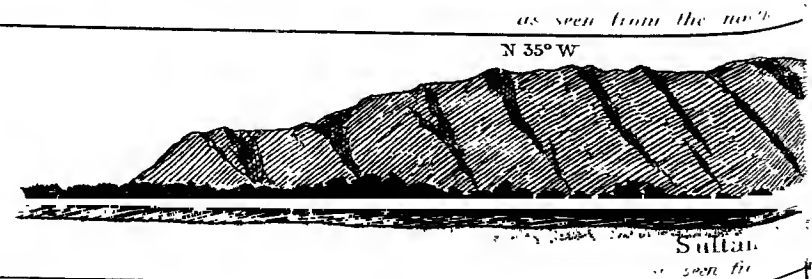
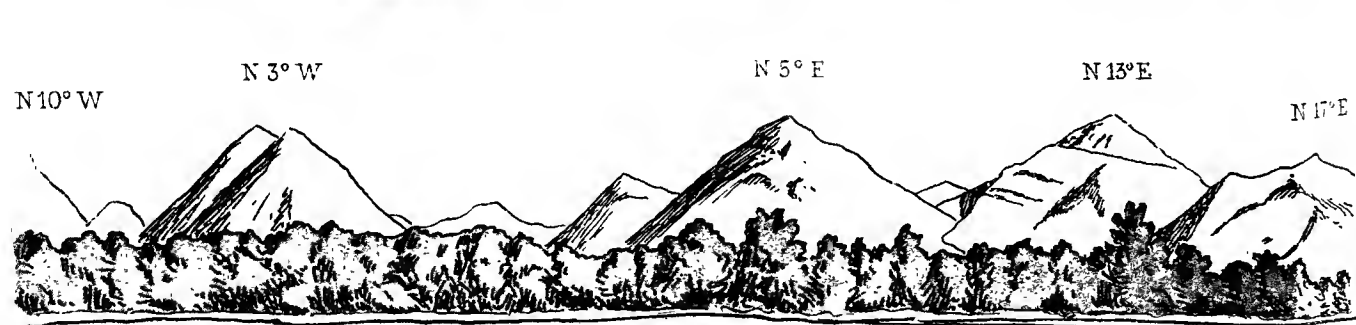
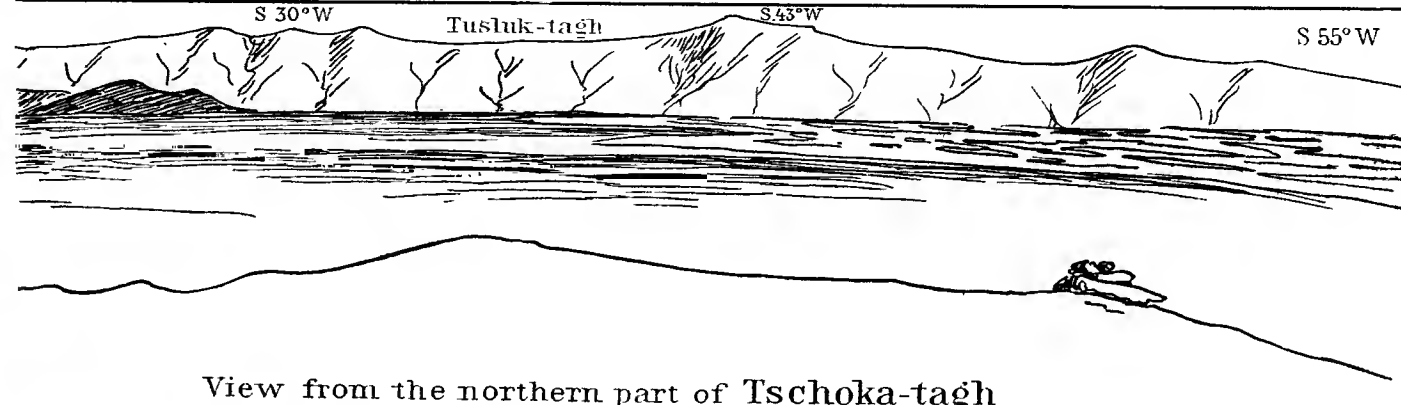
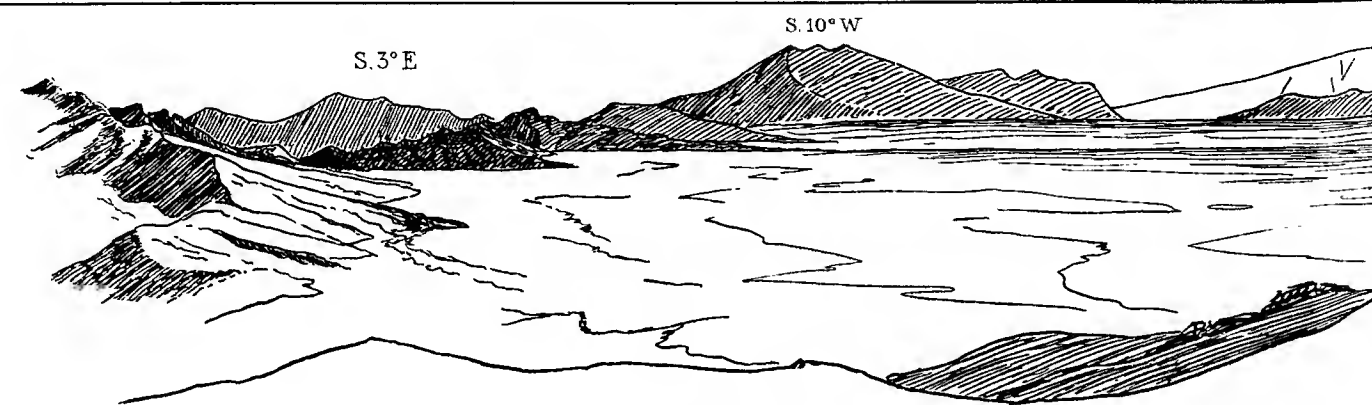
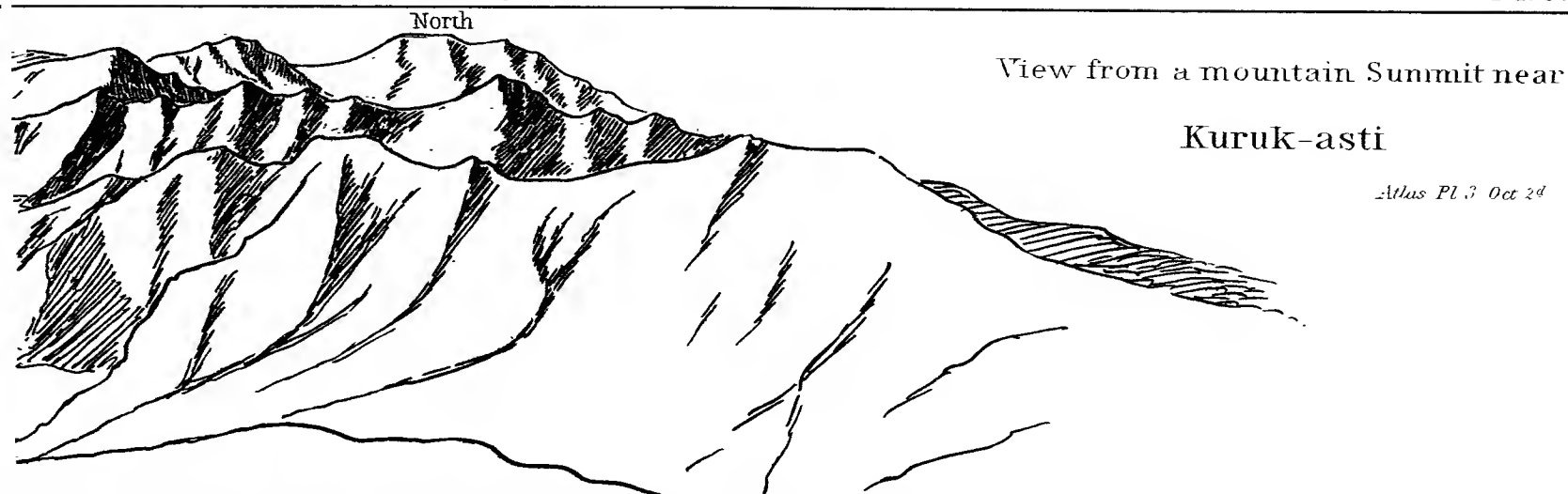
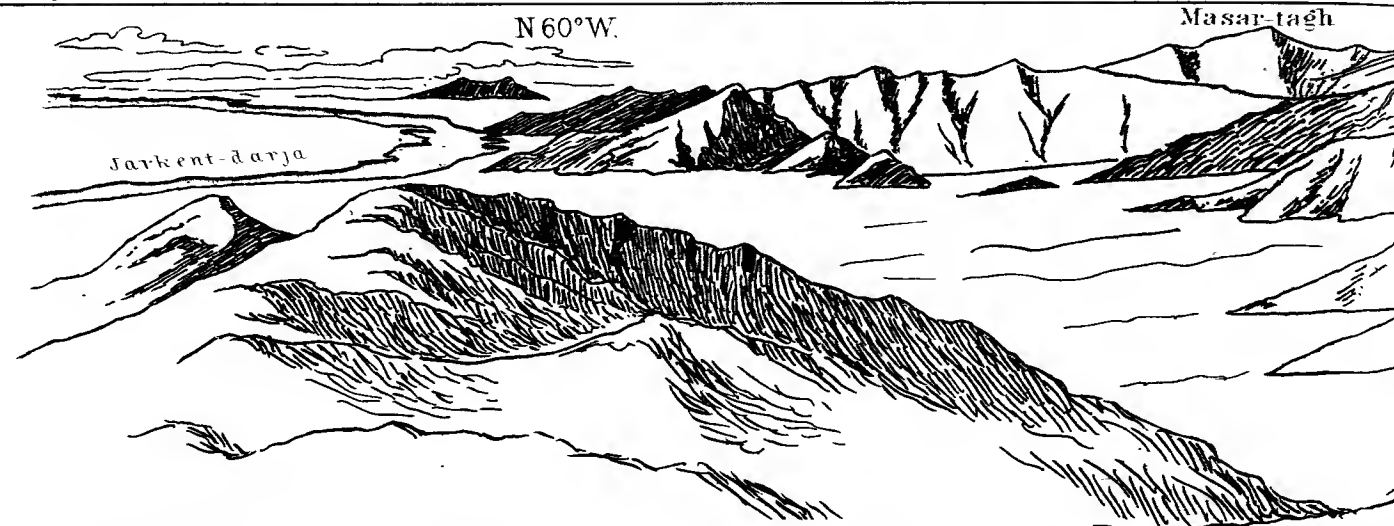
Fig. 51. THE CHANNEL BETWEEN SORUN-KÖL AND TSCHÖL-KÖL.

appreciably lower than it was in the height of the summer. Similar lateral lakes or lagoons are very common, especially along the lower course of the Jarkent-darja, for the most part on the right side of the stream; they prove, wherever they occur, that the country there lies at a lower level than the surface of the river.

Wild-duck swarmed in extraordinary numbers on both these lakes, and on the Sorun-köl there were also some swans.

I have described the Tschöl-köl in *Petermann's Mittheilungen* (Ergänzungsheft, 131) in the account of my 1895 journey, and consequently there is no need for me to dwell upon it again here. Except for its northernmost extension, where there







occur some few reeds, it is an entirely open sheet of water. Its contents are perfectly fresh to taste, a natural consequence, of course, of the free circulation backwards and forwards through its feeding channel, by which, as I have explained, it also discharges. At the same time, it is reported to acquire a faint, and scarcely perceptible, flavour of salinity when the lake reaches its lowest ebb, more especially in its southern extension, which lies farthest from the canal. Considering that the



Fig. 52. TSCHÖL-KÖL LOOKING S.S.E. FROM ITS NORTHERNMOST PART.

lake receives a larger volume of water than it discharges, one would expect it to exhibit greater salinity than it actually does. The Algæ growing at the bottom of its connecting channel also showed plainly which way the current was flowing; the fact of their streaming southwards even then, when the Jarkent-darja was steadily falling, proved that there was a current setting towards the Tschöl-köl. And as a matter of fact, the Sorun-köl was, as we have seen, still receiving an influx from the river.

When I visited this region in 1895 I was separated from the Tschoka-tagh by the lake of Tschöl-köl. I resolved therefore to complete my map by making an excursion on foot across this little desert range. As we advanced from the lake-shore to the detritus scree that masks the foot of the mountain, we crossed a succession of concentric rings disposed around the lake. First came *schor*, or saliferous mud, white on the surface and slightly moist, it having been only recently exposed, since the lake began to shrink. Next followed kamisch steppe; and then a second belt of *schor*, perfectly dry, and concentrated into granulated, transparent crystals. The last distinctly marked shore-line was encountered at a distance of 1.8 km. from the lake, the point to which its waters advance when the river runs high. From



Fig. 53. TSCHOKA-TAGH AS SEEN FROM ITS NORTHERNMOST PART. TO THE RIGHT, THE HIGHEST TOP OF THE MOUNTAIN IS TO BE SEEN IN S. 22° E.; THE TOP TO THE LEFT IS SITUATED IN S. 43° E.

that line the scree began to rise at an angle of  $3^{\circ}$ , the surface being strewn with sharp-edged gravel and furrowed by innumerable tiny torrents, which become more and more split up and divided like dried up deltas in proportion as they approach the shore. In the upper parts of the scree these rivulets have cut their way down to a depth of 1 m., and their sides are vertical. This proves unmistakably, that heavy and violent rains do fall there sometimes, though it happens no doubt extremely seldom. Here we found some tamarisks; and as we advanced, the surface became more broken and irregular. The main ridge, which is flanked by smaller parallel crests, attains an altitude of about 200 or 250 m. The rock formation is that already described, and it had a dip of  $31^{\circ}$  to the N.  $50^{\circ}$  E.



Fig. 54. PROFILE OF TSCHOKA-TAGH; TO THE LEFT IS TSCHOL-KOL.

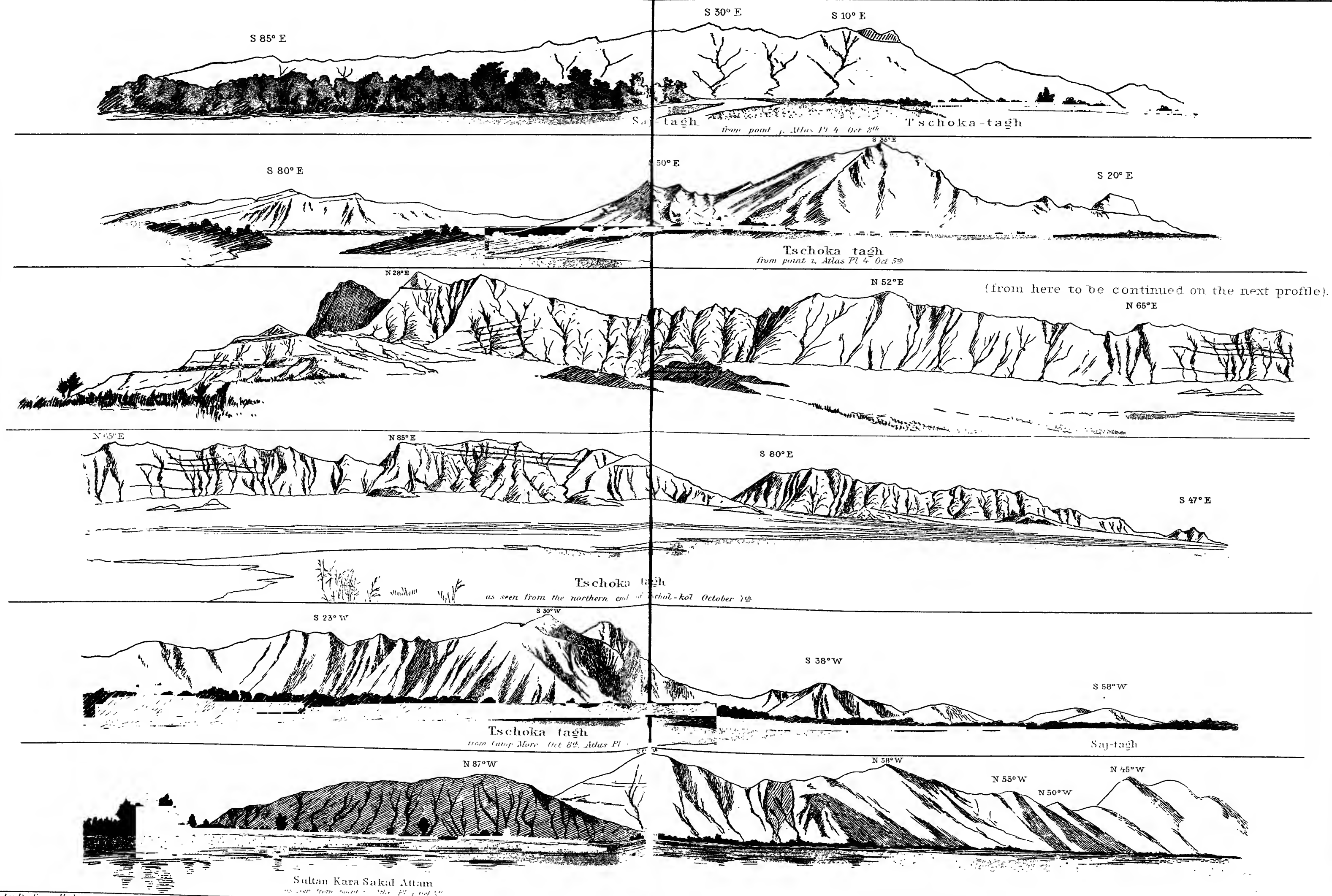
From the top we commanded a bird's-eye view of the lake. It was long and narrow, though at the same time broader than I supposed it to be in 1895, when it had the appearance of a mere fringe along the foot of the mountain. Now, however, I perceived that it actually lies nearer to the Tushuk-tagh than to the Tschoka-tagh (see map I in *Peterm. Mitt.*, Ergänzft 131). The southern extremity of the lake, which I travelled round in 1895, appeared to present precisely the same outline as on that occasion. There is a low-pitched gravelly scree at the foot of the Tschoka-tagh, corresponding to that at the eastern foot of the Tushuk-tagh, and it is approached pretty closely by the high sand-dunes of the desert, only a narrow belt of schor separating the two. Although we passed a stretch of dead forest, with sapless trunks, we did not come upon living forest until we reached the Saj-köl. The eastern side of the Tschoka-tagh is much steeper than the western side, which presents a long and gradual ascent.

October 8th. During the last 46 hours the river dropped 4 cm. The transparency measured 34.5 cm. yesterday, and 38 cm. to-day. The stream was gradually clearing in consequence of the diminishing volume and slower rate of flow, the latter circumstance being also a consequence of the former. Another factor which likewise contributed to increased transparency was the seasonal fall in the temperature.

At first, after we started again, the river was broad, with a slow current, and after describing a long loop, it washes on the right the foot of the Saj-tagh, only leaving room for a sheep-track and a few young poplars. The flank which the mountain turns towards the river goes down at an angle of  $34^{\circ}$ , and consists of bare rock; whereas the eastern slope is buried under drift-sand. The disposition of the strata was easily distinguishable: they crop out in black bands and projecting cornices everywhere on the mountain sides, and lie at an angle of  $47^{\circ}$  to the S.  $75^{\circ}$  E. The axis of the Saj-tagh stretches north and south, and is continued in the former direction by a small chain of lower heights, all abutting immediately upon the river, which is thus compelled by them to describe a long detour or loop to the north. The first bluff we









PL. II.



*Lynce, A. B. Lagrelius & Westphal*

THE MASAR AND GHURISTAN OF SAJ-TAGH.



came to was crowned by a *gumbes*, standing in the midst of a number of graves (*guristan*), each provided with a tombstone of clay, resembling in shape a brick or a cigar-box. There is an abundance of poplars in the locality, and the drift-sand has in places heaped itself up into dunes. From one of the summits we obtained a good general view of the surrounding country. Due south rose the main peak of the Tschoka-tagh, with the Saj-tagh in the foreground. Next to us on the east was a dense poplar forest, its foliage now turned yellow. To the south-south-east and the south-east was a patch of the high barren sand, an outlier of the Takla-makan. The principal summit of the Tusluk-tagh lay S.  $40^{\circ}$  W. North-westwards extended the steppe, dotted over with patches of dark green forest-trees and clumps of fiery yellow bushes; this region is called Bisch-kotan. Immediately to the north the Saj-tagh terminates in a little eminence not more than 50 m. high. Beyond it in the far distance was Sultan Kara Sakal Attam, with its five culminating peaks. The river serpentine through the country like a broad conspicuous ribbon, its long leech-shaped sedimentary deposits now gradually emerging to light as the water dropped. On the little protuberance of the Saj-tagh, on which we stood, there were yet two other graves, covered, not by the usual dome, but by an arrangement of beams and stones. Both were open at their northern end, and thus showed the heads of the skeletons, which had been laid north-and-south. In one of the graves there were two skeletons. Neither grave appeared to be very old.

On the other side of the mountain the steppe predominates, until it is succeeded by fine young forest. Here the river describes longer windings, and its bed is deeply trenched, the banks being  $1\frac{1}{2}$  m. high, while the alluvial deposits are insignificant. On the right we passed a Kona-darja, an arm which had run closer in under the Saj-tagh than the present channel does. Deer were common in this locality.

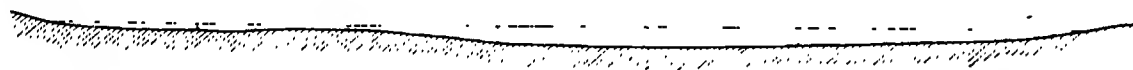


Fig. 55. Right. 0.30      0.16      1.05      1.21      1.08      0.79 = depth. Left.  
                  30            20            58            87            78            63 }  
                  21            15            50            79            68            52 } velocity.  
                  Breadth = 67.3 m. More, October 8. Scale 1 : 500.

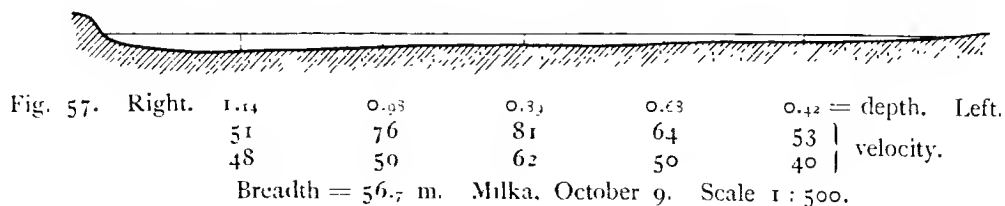
At More the river was 67.3 m. broad, and had a mean depth of 0.656 m., a mean velocity of 0.5913 m., and a volume of 26.10 cub. m., in the second.

October 9th. In the course of 12 hours the level dropped 2 cm. The transparency was 29.7 cm. At Kala-dung on the right bank the forest is quite luxuriant. A little below that point the river divides into two branches, of which the left one alone contained water. At one of the sharp bends, where the current was making havoc of the bank, some of the outermost poplars had fallen and lay upon the surface, where their branches arrested and held fast the driftwood, and other flotsam and jetsam, that came floating down-stream. In another place, where the river was only 30 m. wide, a prostrate poplar stretched half-way across it, and on the other side of the tree the depth increased to 8 m., while the banks were 1 to  $1\frac{1}{2}$  m. high. At Öschkä-öldi a branch strikes off from the right and proceeds to



Fig. 56. HIGHWATER MARKS ON THE BANKS OF JARKENT-DARJA.

a marginal lagoon two days' journey lower down the river, known as the Jantak-köl. It was reported to be then empty, though it had been filled with water at the period of high flood. The upper part of this side-arm bears the name of Jantak-köl-aghsi. During the course of the day we passed the following forest-tracts — Siva-kotan, Kăpă, Jătim-kirlidi, and Milka. In the last-named locality we observed a masar, situated amongst some sand-dunes, scantily covered with vegetation. Here on the left bank was a shepherds' track, running from the Kodaj-darja to Avat and Ak-su. At this place the river was 56.7 m. broad, and had a mean depth of 0.685 m., a mean velocity of 0.5533 m., and a volume of 21.49 cub. m., in the second.



October 10th. A drop of 1.7 cm. in level; the transparency being 37 cm. For a space the stream serpentine in an unprecedented way. At Ghirlang and Ak-jarsik the woods are again very fine. Here too wild-boar were abundant. By

this the foliage of the trees was yellowing rapidly, a green leaf being indeed a rarity. When the wind blew, the surface of the stream became thickly littered with fallen leaves, and these, when they rot, help to form ooze at the river-bottom. We only came across one shepherd encampment, although in many places the scorched tree-trunks betrayed where their camp-fires had been. At Ak-satma we found a *baj*, or »rich man», who owned 2000 sheep, besides a number of cows. Beside his homestead, which consisted of two huts, he grew wheat and melons. Thence a foot-path led to the village of Pitschak-sindi, some 20 km. to the north. Below Ak-satma the breadth of the river was 46 m., its mean depth 0.905 m., its mean velocity 0.5500 m., and its volume 22.90 cub. m., in the second. These data are not however altogether reliable, because they were taken at only three points. There is, however, nothing inconsistent in the volume measuring more on one day than on the day preceding, because not only does the influx from the mountains vary from day to day, but the rate of the current's flow is also affected by changes in the pressure of the atmosphere.

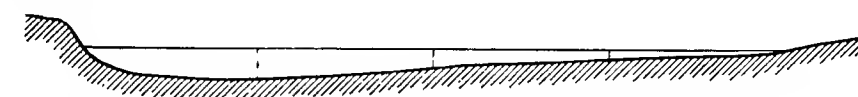


Fig. 58. 

1.95	1.06	0.61 = depth.
64	47	37
77	59	30

 } velocity.  
Breadth = 46.0 m. Ak-satma, October 10. Scale 1 : 520.

October 11th. A drop of 1.2 cm. The level sinks from 1 to 2 cm. every night, or on the average 3 cm. in the twenty-four hours. The transparency amounted to 31.5 cm. The extensive marshy bends which the Jarkent-darja describes hereabouts are choked with steppe, brushwood, bushes, and thickets, intermingled with occasional clumps of poplar. At one of its acutest angles, however, the breadth did not exceed 15.4 m., while the depth was 4.20 m. Kuschke, Jantak-köl, and Dugha-dschaji are the chief topographical names. Close to the south bank of the river we here came upon the lake of Jantak-köl already mentioned. The nearest stations on the great Ak-su caravan-road (*Kan-joli*, i. e. »Main or Royal Highway») are Tumschuk and Tschadir-köl. In the same direction, between the Kaschgar-darja and the Kodaj-darja, stands the old and venerated tomb of the saint Ikki Dschan Pena Masar Chodschan, with, I was told, a village of about 30 families, and some sheikhs, a prayer-house, and several *gumbes*, with streamers fastened to poles, so-called *tughs*. This masar, which is visited by pilgrims from Kaschgar, Maral-baschi, and Ak-su, is said to stand about 6 km. south of the Ak-su road, being separated from it by a small lake, which I take to be a part, or perhaps all that remains, of the marsh of Lalmoj. That this marsh will disappear, if it has not already done so, admits of no doubt, for, owing to its extreme shallowness, it is bound to become choked with sedimentary matter. The

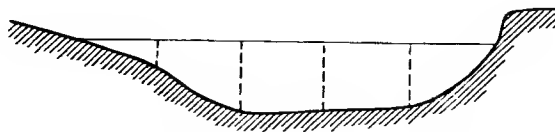


Fig. 59. Left. 

1.89	4.90	4.56	4.10 = depth.
13	24	24	34
17	22	13	38

 } velocity.  
Breadth = 27.00. Dugha-dschaji, October 11. Scale 1 : 500.



district is said to be traversed by an ancient highway, passing the two villages of Jigde-örtäng and Kök-tschol, due north of Dugha-dschaji.

At our camp at this last-named station the river measured 27 m. in breadth, 3.090 m. in mean depth, 0.2245 m. per second in mean velocity, and had a volume of 18.73 cub. m. in the second; these results again being a little uncertain by reason of the great depth. In the bend which the river makes at Dugha-dschaji there were several hydrographic peculiarities, such as counter-current, eddies, and reaches of »dead» water.

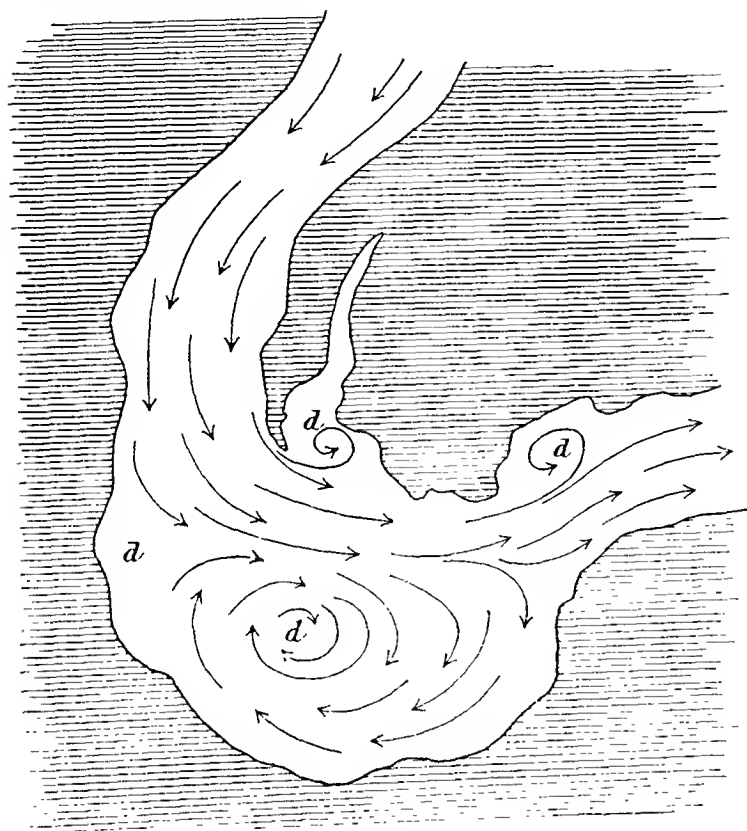


Fig. 60. THE BEND AT DUGHA-DSCHAJI.  
— *d* = DEAD WATER.

October 12th. A drop of 1.2 cm. Transparency, 39.1 cm. During the night the thermometer went down to  $-1.1^{\circ}\text{C.}$ , and we had the first frost of the autumn. In the vicinity of our camp the river-banks were 2.08 m. high, but appeared, notwithstanding, to have been covered at high flood, for the sandy soil of the right bank was still moist up to the top and also at some distance from the edge. On the crescentic alluvial promontory, on the opposite side of the river, we noticed a *tor*, that is a kind of springe to catch birds of prey in, which the neighbouring shepherds had set. It consisted of four rods, stuck into the ground and meeting together at the top, with a net let down inside them. Inside the net a pigeon or hen is

fastened, in such a way that, when the hawk darts down upon its prey, the tops of the rods spring apart and close the opening of the net.

The farther we advanced the more serpentine became the river, as well as, at the same time, both narrower and deeper. The country still preserved the same features as yesterday, although dense forest was less common. In fact, it was becoming evident, that the belt of vegetation which accompanies the river, is only narrow; we seldom had a vista of deep, dark forest. There were a couple of leafy huts at a place called Ak Supa Baj-kotan on the left bank. The first big loop to the south brought us, I was given to understand, to the most easterly extension of the now desiccated lake of Jantaklik-köl. Beyond it the locality is known as Numet-bulung. At Sävät-asti an old disused channel leads off through the right bank; it was reputed to be the beginning of the mysterious Kara-saj, which I have

adverted to above. There we found four shepherds dwelling, in charge of 800 sheep, belonging to bajs of the villages situated on the great Ak-su highway. In an exceptionally regularly formed loop — a part of it indeed described a perfect circle — in the district of Tugha-pangsa-jokarki-baschi, or »The Upper End of the Camels' Grazing-grounds», we again measured the river. The breadth was 54.25 m., the mean depth 0.588 m., the mean velocity 0.5699 m. in the second, and the volume 18.18 cub. m. in the second.



Fig. 61. Left. 0.50      0.88      0.75      0.81 = depth. Right.  
           46        80        70        62 } velocity.  
           39        60        48        69 }  
 Breadth = 54.25 m. Tugha-pangsa-jokarki-baschi, October 12. Scale 1 : 520.

October 13th. The drop in 12 hours was 1.4 cm.; the transparency, 38.3 cm. In this part of its course the river was more sinuous than it had ever been before. Once we spent 3½ hours in circumnavigating a loop, and at the end of that time found we had only advanced a matter of a couple of hundred meters. Forest still continued to alternate with steppe. A double loop that we threaded bore the name of Kirk-kischlak, or the »Forty Camps». At Toghri-kum, or the »Straight Sand», on the left bank, there are sand-dunes of considerable height, overgrown with vegetation; and here the Jarkent-darja is joined by a branch of the Kodaj-darja, though it had been dry since the previous year, and its mouth was then completely stopped up by the sand and sedimentary matter which the Jarkent-darja had discharged into it during the period of high water. The course of the old stream was, however, plainly indicated by the open passage-way it has cut through the forest. But although the water forces its way into its lower part from the Jarkent-darja at the season of high flood, it does not penetrate any great way up. The distance between Toghri-kum and the station of Tschadir-köl on the great Ak-su caravan-road is reported to be about 24 km., and the direction N.10°W. The intervening stretch of country is crossed by two branches of the Kodaj-darja, and at a place called Kengrak-örtäng by the above-mentioned ancient highway, as well as by the Kara-jilgha-darja. This last derives its water partly from the Kodaj-darja and partly from the Kaschgar-darja; and it is upon it that the station of Tschadir-köl is situated.

At Toghri-kum the river was 54.10 m. broad, and had a mean depth of 0.728 m., a mean velocity of 0.4894 m. in the second, and a volume of 19.28 cub. m. per second.

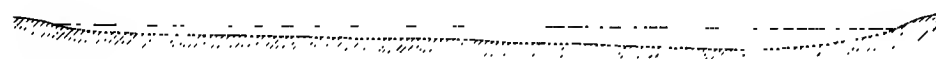


Fig. 62. Left. 0.48      0.65      0.80      1.12      1.34 = depth. Right.  
           42        53        52        60        58 } velocity.  
           33        30        36        59        68 }  
 Breadth = 54.10 m. Toghri-kum, October 13. Scale 1 : 520.

October 14th. The river subsided 0.7 cm. in 12 hours; and the transparency was 39.0 cm. Two of the Kodaj-darja's anastomosing arms are said to reunite in

a locality called Kara-buka, half-way between Toghri-kum and Ghascha. At the latter place, which is on the right bank, there are magnificent old poplar woods. At Kurdscheklik, on the left bank, the river is touched by a shepherds' track which leads to Avat. On the same side of the river, at a place called Kislar-sarati, or the »Maidens' Burial-place«, there stands an unimportant masar amongst some poplars. Thence a small artificial canal carries water to a spot where the shepherds of the neighbourhood grow wheat. Close by, the river describes a rectangle in the forest known as Sanijä-satmasi.

During the course of the day the appearance of the river altered very materially. It was straighter than it had been anywhere since we left Kötäklik; it was broad and shallow; and the long windings, with their counter-currents, eddies, and »dead« water, were here entirely absent. At the same time there was a great accumulation of alluvial deposits; in fact, they occupied one-half of the river-bed. The banks were still sharply cut, though not more than  $1\frac{1}{2}$  m. in vertical elevation. Along the banks steppe predominated, alternately with bushes and clumps of poplars. At Jigdelik there were again sand-dunes, overgrown with vegetation. One of the dunes, Kade-dung, or the »Pole-Hill«, bore a pole by way of *nischen* or »landmark«, to indicate, that there was a masar in the vicinity. Thence we perceived, at a distance of about 10 km., in S.15°E., a very lofty double dune, and on the nearer side of it ran, according to the information supplied by my guide, the Kara-saj, which I have already mentioned more than once before. This mysterious watercourse would consequently appear to traverse a very considerable extent of country, for we had been hearing of it all the way from Sorun. So far as we were able to make out from the top of Kade-dung, the space between the river and the big dune appeared to be occupied successively by living forest, barren steppe, dead or dying forest, and the naked earth, swept clear of sand, but with fragments of flint scattered thinly over it. There is barren sand again in the south-south-west, although it is not so high, with the hard exposed earth, which the natives call *saj*, stretching from it towards us. At Kara-saj there is a gumbes of the same type as the one at Saj-tagh; that is to say, it is built of clay and stone, and is surrounded by a smaller *guristan* and two or three artificially dug earth-caves, which appeared to have been once inhabited, though it must have been a long time ago. The neighbourhood was scoured in vain for other indications of human beings, or other traces of human dwellings.

October 15th. In the course of 17 hours the river rose 0.65 cm. The transparency measured 34 cm. at 7 a. m., and 38 cm. at 1 p. m. At first the course of the stream was very winding, but during the latter part of the day we only encountered one big loop going towards the north. Sometimes for a short stretch the river would turn through every point of the compass. The current was as a rule swift. It may be laid down as a general rule, that where the river is sinuous it is at the same time narrow and deep, with a sluggish current; but where it is straight, it is also broad, shallow, and rapid. In the former case there is no alluvial formation worth speaking about, and the banks are higher; in the latter case there are extensive accumulations of alluvium, and the banks are lower, while at the same time the sedimentary deposits cause the current to split into two, or



*Lynceus A. B. Lagrelius & Westphal.*

SHEPHERDS' HUTS NOT FAR FROM SORUN.



sometimes even three, arms. A shepherds' track goes off from the right bank to Avat. The woods bear the names of Nakara-chane and Sait-satması. The locality of Kälpin, situated 6 or 7 km. back from the left bank of the river, procures water for its wheat-fields through an irrigation channel which leaves the Jarkent-darja at Islik. There too, but on the right bank, are some ancient poplars growing beside a sand-dune. Here the breadth of the river was 33.2 m., the mean depth 0.899 m., the mean velocity 0.7531 m. in the second, and the volume 22.47 cub. m. in the second.

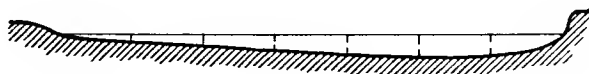


Fig. 63. Left. 0.41 0.72 1.08 1.31 1.40 1.38 = depth. Right.  
 52 86 92 90 92 70 } velocity.  
 41 77 83 83 83 78 }  
 Breadth = 33.20 m. Islik, October 15. Scale 1 : 520.

October 16th. During the night, that is in 12 hours, the level *rose* 0.6 cm. The transparency was 37.8 cm. at 7 a. m., and 35.4 cm. at 1 p. m. To-day the great river was rather less sinuous than before, though we had both straight and winding stretches, now a broad, now a narrow bed, and sometimes a slow, sometimes a swift current. The containing banks were as usual strongly scarped, sometimes on one side only, as at the bends, or where the river traversed a straight stretch on both sides together. In one place, which was sandy and fringed with poplars, the bank was as much as 3 m. high. The poplar woods were both dense and luxuriant, and were sometimes interrupted by young wood or bushes; but between them and the river's brink was a narrow belt of steppe. During the latter part of the journey we frequently had sand-dunes on our right, generally situated in the middle of the poplar woods; but then the »ocean of sand» was only two or three kilometers distant. Consequently the fringe of poplar forest which accompanies the river is in these places of no great width; indeed it clings anxiously to the stream. The forest on the right bank is called Jalghus-tal-jingpang; the corresponding tract on the left bank, Sadet-bekning-lämpäsi. Here the Kodaj-darja is only three kilometers distant from the Jarkent-darja. Two years previous to my visit the latter deserted an older channel at Moghal-satmasi, or the »Mongol Hut», an interesting name, by the way, as it probably points to the fact of Mongols having been settled there at some time or other. But although the stream had cut through the neck of land, and left the deserted loop on one side, there was still a crescentic pool of stagnant water remaining at its deepest and remotest angle. A fragment of the neck of land through which the current had broken likewise survived in an islet, of about 20 meters diameter, standing in the throat of the new channel. The interior of the



Fig. 64. 1.08 1.00 0.40 = depth.  
 81 84 38 } velocity.  
 74 74 30 }  
 Breadth = 48.00 m. Kujluschning-baschi, October 16. Scale 1 : 500.

loop, round which the abandoned channel circled, was occupied as usual by a large reed-grown island, with a steep face on the west and a backing of naked alluvium on the east. At Kujluschning-baschi there was another similar abandoned loop on the left bank; it too still retained water in it. Here we found a flock of 800 sheep belonging to a baj of Ak-su. The river was 48.0 m. broad, and had a mean depth of 0.620 m., a mean velocity of 0.6611 m., and a volume of 19.68 cub. m., in the second.

Here I may perhaps suitably point out a circumstance which was told me by the shepherds of the vicinity, and which, though I had no opportunity to observe it myself, seems to be sufficiently reasonable. Although, as we have seen, the level was steadily falling at the rate of  $1\frac{1}{2}$  cm. every night, the natives declared that, when the ice began to form, in about seven weeks' time, the river would be no lower than it was then in the middle of October. The explanation of this is, that during the latter part of the autumn the Jarkent-darja is continually fed, chiefly by means of invisible underground springs, from the superfluous overflow of the irrigation canals after the fields have been sufficiently supplied in the spring and summer. Besides this, at the same season the little streams which drive the mills, and water the patches of cultivated ground in the immediate vicinity of the river, all begin to return to the mother stream. And it is not until late in the autumn that these subterranean supplies manage to reach their original source; thus it is their steady reflux which maintains the great river pretty constant in the season immediately preceding the formation of the ice, or at all events which retard the fall so effectually that it is scarce perceptible. Theoretically this explanation is very plausible; indeed, the river is even said to rise slowly sometimes in the middle of November. During the summer the Jarkent-darja swells out in this part of its course to an enormous width, so that it is quite spring before it admits of being forded.\* Here also we noticed occasionally the tracks of tigers. These animals frequent more especially the desolate districts on the right bank, and shun as much as possible the propinquity of man. As for the wild camel, our shepherd informants had only heard speak of him; they had never seen one.

October 17th. During the night the river rose 0.51 cm. The transparency was 34.5 cm. Immediately below our camp the Jarkent-darja was joined from the left by the arm of the Kodaj-darja called the Kara-jilgha-darja, or the »Black Valley River»; the confluence being named Kalughutsch or Kujlusch, i. e. »the Confluence». This is the same arm which we have seen starting off at Kuruk-asti, two weeks before, though its channel was then dry. But at Kalughutsch it carried a volume equal to five *tägirmän-taschlik-su*, or as much water as would turn five millstones; that is

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\* Some conception of its dimensions may be obtained from Pjevtsoff's description of it in the region just below Aksak-maral. In the latter half of June he observed that the river increased in volume every day, and at a noticeable rate. »Every moment huge masses of earth kept toppling down its steep banks as they became undermined by the rapid current, their fall violently agitating the water, and branches, even entire trees, went spinning along on the current, which was moving at the rate of 4 or 5 feet in the second.» Yet he was told by the natives, that the river would not attain its maximum flood before the beginning of July (O. S.). Immediately above Lajlik he found that the river had a breadth of 2 versts (2132 m.), as compared with a breadth of 134 m. at the time I measured it at the same place. In other words, the Jarkent-darja at the season of full flood must present a totally different appearance from what it does in the autumn.

to say, it was a quite inconsiderable and imperceptible quantity. The reason there was a current at all in its lower course, seeing that all accession of water had been so long cut off from above, was due to the fact that the deeper parts of its bed, as well as the occasional marginal lagoons which depend upon it, empty themselves only gradually. At the angle of the confluence there was a miniature pool. To judge from the shape of the Kara-jilgha-darja, and the sedimentary deposits in its mouth, it must, at the season of high flood, be a stream of some magnitude. On the other hand, relatively to the existing and comparatively new bed of the Jarkent-darja, it is itself growing year by year smaller. It was described as being narrow and deep (*oj*), whereas the Jarkent-darja is broader and shallower (*takta*).

A shepherds' track leads across the river from the confluence to Avat; while another traverses the forest at a distance of two or three kilometers from the left bank. On the edge of the sandy desert, about  $1\frac{1}{2}$  kilometers east of the river, stands the little masar of Ghesi-gumbes. Thence the stream flows for the most part to the north. The shepherds were of opinion, that at the next flood season the river would cut off the first big loop by forcing its way through the narrow isthmus at its base. The banks in the loop were as much as 4 m. high. Upon reaching the forest region of Tongus-burun we found ourselves opposite to Dungsarat, Ottus-kemi, and Jaka-kuduk — all places lying to the north-west. Then came a loop abandoned two or three years ago, but still containing a deep, narrow pool. Both extremities of the loop had been swept so thoroughly by the last full flood that we were able to see to its head. A little bit lower down we passed the beginning of an old bed deserted about 30 years ago. It is now completely overgrown, though its left bank, 3 m. high, still remains unimpaired. In the locality of Tapsi, again, the river left behind it, two or three years ago, an abandoned loop, which is now called Tapsi-köl. There we found shepherds living. On the right bank there is a shepherds' path leading to the saint's tomb of Masar Chodscham; and just below that yet another Kona-Jarkent-darja struck off from the channel we were navigating. The place where this begins is called Kum-ägis (also Ägis-kum), or the »High Sand», from some sand-dunes which have been formed in the bed of the Kona-darja itself. At Jar-kotan we again passed a loop on the left, which, strange to say, was a double loop. Its inner spiral was three years old; its outer one was only abandoned a year ago.

During the course of the day the river again altered its character to some extent. Mature forest was practically non-existent; there was nothing but young wood or bushes, a circumstance due in part to the changeableness of the river in that region. Steppe predominated; sandy ground, dotted with scrub, was common; and often the banks were marked by sand-dunes, upon which the erosive force of the current was playing with swift and disastrous effect. The large number of abandoned loops shows that the river hereabouts frequently changes its direction, though generally only for a short distance at a time. The chief cause of the river's variability is the small coherency and loose character of the soil, which owing to the absence of forest is not sufficiently bound together by strong, interlacing roots. Time after time we had unmistakable evidence of the quite recent desertion of this or the other loop. Time after time, too, we perceived the poplars standing



on the brink of the 3 meter high bank, ready to topple into the stream; while others, recently undermined, lay prone on the surface, but still held fast by their roots. All along, the vertical face of the banks was corniced with roots hanging out over the current. In the shallow reaches the long kamisch roots projected from the bottom, and undulated like snakes on the surface. Here the river-bed was tolerably broad and shallow, and the current swift. At Jar-kotan there is a wide

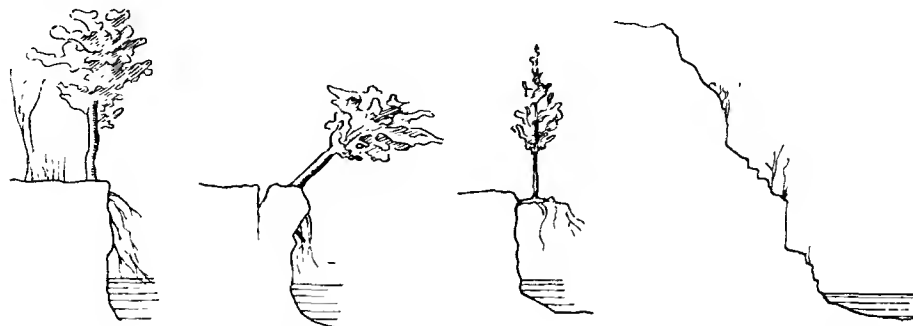


Fig. 65. ERODED BANKS; POPLARS READY TO TOPPLE INTO THE STREAM.

expansion, mostly filled with alluvial deposits. Just below this spot the width measured only 19.55 m., the mean depth was 1.204 m., the velocity 0.7744 m., and the volume 18.23 cub. m., in the second. After the influx of the Kara-jilgha-darja, though its volume is, it is true, slight, one would have expected to find a rather bigger volume than that given by the previous measurement. However, the increment was not powerful enough to affect the steady fall in the river.

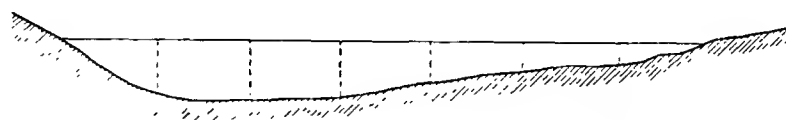


Fig. 66. 

1.74	1.92	1.80	1.38	0.95	0.64	= depth.
70	91	100	82	79	51	} velocity.
85	101	99	82	59	27	

  
 Breadth=19.55 m. Jar-kotan, October 17. Scale 1 : 250.

## CHAPTER IV.

### THE KODAJ-DARJA AND THE KASCHGAR-DARJA.

October 18th. The level remained unchanged during the night. The transparency was 24 cm. at 7 a. m. and 20 cm. at 1 p. m. This decreasing transparency was due to the hesitancy of the stream, which caused it frequently to alter its course. As a consequence of this, the banks consisted in many places of fine, loose material, which, not being yet consolidated and held fast by tree-roots, is constantly being washed away by the current. Add to this the effect of the wind, for the water is always more turbid on a blowy day than on a still day. The stationary reaches immediately below the banks were broken into waves, and these, playing upon the loose material behind, caused it to crumble, and so 'muddied' the water. In windy weather, too, we noticed that there were more drift-wood, and larger quantities of reed *débris* and broken branches, floating on the surface than at other times. These were partly *dissecta membra* blown off the banks into the river, partly materials which had become fastened in the bottom, and were now loosened and set adrift again by the combined action of the wind, the movement of the waves, and the counter-currents of the surface.

Generally speaking, the river in this part of its course gives the impression of being less at home than hitherto. At intervals we passed, now on the one side, now on the other, deserted banks lying quite high and dry, though some of them are obviously reached by an arm of the river at the period of high flood. Otherwise they are as a rule separated from the existing channel by a thin belt of steppe. Towards both banks the river-bed contains vast deposits of alluvium, more or less exposed and dry. Poplar forests were by this become extremely rare; indeed, we only saw them on the deserted banks. Their place was taken by tamarisks and steppe scrub. The beautiful headlands, with their shady groves of poplars, which are so general where the banks are more permanent and the woods have had time, as it were, to order and arrange themselves, and so grow up quietly, enjoying the advantage of a regular supply of moisture — these had now virtually ceased. These open reaches are, however, especially exposed to the effects of the wind in the way I have just described. Wild-geese were now very common; every day we saw numerous flocks wending their way up-stream. Wild-duck were also met with.

The names of the wooded tracts encountered during the course of the day were Suget-tokaj on the left bank and Tschajlik on the right. Then followed an abandoned loop (*boldschemal*), and next, on the left, a branch, at that time dry, which is however filled at high flood, hugging a deeply scarped bank. In the direction N. 30° W. from that point stands the station of Suget on the road to Ak-su, and the station Jirinde on the older highway I have mentioned. After that comes, on the left of the river, Atschi-dung, and on the right Käptär-asti. Here the Jarkent-darja is crossed by the boundary between the administrative districts of Ak-su (to the east) and Jarkent (to the west). At our camp the river was 33.3 m. broad, measured in mean depth 1.140 m., and in mean velocity 0.5183 m., and had a volume of 19.68 cub. m. per second.

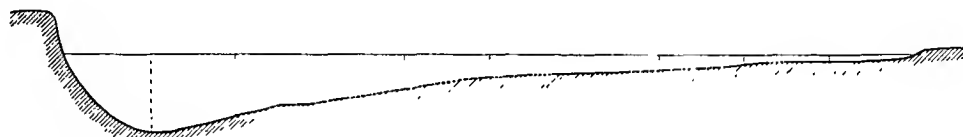


Fig. 67. 

3.00	2.33	1.96	1.32	0.98	0.71	0.55	0.36	0.19
52	80	70	60	51	38	30	18	1
50	78	67	56	40	33	20	3	0

 }   
 Breadth = 33.30 m. Atschi-dung, October 18. Scale 1:300.

October 19th. The subsidence was 0.6 cm. The transparency 21.4 cm. At first the river flowed tolerably straight. At the first bend there were some not inconsiderable sand-dunes on the left bank. Here also the road to Avat, *viâ* Palas-japte, touches the river. To the north stretches a desolate desert-like region. In this locality the river grows very wide at the period of full flood, its bed presenting as broad an expanse as at Lajlik. On the left we have the remarkably luxuriant woods of Tschubuk, and on the right Kumusch-satma. Then, after passing a loop, with stagnant water and an island, which was abandoned in the preceding year, the river flows tolerably straight towards the east, with occasional small silt islands in the middle of its channel, and drift-wood anchored to the bottom in shallow places. We made our camp in a neighbourhood known as Dung-gerem, situated about 25 km. south of the great Ak-su road, and 18 km. from the Kaschgar-darja. In the same direction, that is on the south of the last-named stream, there are an old river-bed and a long, narrow belt of barren sand-dunes; and south of that, again, and quite close to the Jarkent-darja, runs the road to Avat. On the other side of the river is the beginning of the great sandy desert, about 10 km. to the south, bordered on the nearer side by the old bed of the Jarkent-darja which starts, as we have seen, at Kum-ägis.

October 20th. During the night, that is in the space of 12 hours, the river dropped 5.3 cm. The transparency was 26.8 cm. at 7 a. m., but only 17 cm. at 1 p. m. The curves which the stream here describes are remarkably regular in their formation, and at each fresh bend exhibit the same accompanying features and the same arrangement of the riparian forest. At the inner or concave edge of the circumference of the loops the banks are sometimes as much as 5 to 6 m. high. The old banks, which are beyond the reach of the current, generally form the boundary line between forest and steppe, the former growing along their top,



Fig. 68. THE »CHANÉKA» OF MASAR-CHODSCHAM.

the latter below at their feet. Occasionally also their base is bathed by an elongated pool, left by a lateral branch of the river when in full flood. At the angles the depth is always considerable, 5 to 6 m., and sometimes our 6 ft punting-poles failed to touch the bottom. The soil is arenaceous; in several places the banks are actually formed of sand-dunes eaten into by the stream. At Nurma, on the left bank, we found three shepherds guarding 300 sheep. At Kokul the distance to the great desert was given as about 12 km.; and there the Kona-Jarkent-darja was reported as still hugging its margin, though now in great part levelled up and choked with drift-sand. The forest gradually thins out from the river towards the desert. About 6 km. north-west of Nurma, in a locality called Kuruk-köbrük, there is another old river-channel. Kuruk-köbrük signifies the Dry Bridge, and is probably derived from a bridge which once spanned the old stream at that spot, though it now lies high and dry; indeed traces of it are said still to survive. On the other side of this old river-bed, which begins at Atschi-dung and rejoins the Jarkent-darja at Mäsälik, lies the district of Dötschun, on the ancient road beside the Kaschgar-darja, about 20 km. north-west of Nurma. Still farther distant in the same direction, that is at 40 km., stands the station of Tschilan, on the great Ak-su road. Thus in this region there exists an old bed on each side of the existing Jarkent-darja. On the left we next passed an abandoned loop, containing stagnant water; on the right we were still accompanied by the forest path which begins at Tapsi and goes,

*viâ* Masar-Chodschan, to Avat. It is always on the innermost circuit, that is to say, the concave side, of each loop that the forest flourishes most luxuriantly, a circumstance due to the current being pressed, and almost forced, into the vertical bank, by which means the tree-roots are always kept moist.



Fig. 69. ENTRANCE GATE TO MASAR-CHODSCHAM.

The saints' tomb of Masar-Chodschan, which stands a short distance back from the right bank, contains the remains of Hasrett-i-Achtam Resi Allahu Anhu, a Moslem missionary, who is said to have visited this region in the time of the Prophet. It stands amongst a cluster of hills, composed of yellow clay and sand, and is decorated with poles and streamers (*tughs*) and antelopes' skulls, the whole inclosed in a palisade. At the southern end of the inclosure is a *chaneka*, i. e. a »prayer-house», or »oratory», a structure some 10 m. long, consisting of poles, 3 m. high, fixed into the ground and surmounted by a roof. The palisade which incloses the shrine is built up of branches, brushwood, and leaves, and is intended to prevent the cattle and sheep from profaning the sanctity of the place. The precincts are entered by a sort of rustic portal, destitute however of gate or door. The *ajvan*, or »balcony», of the prayer-house looks towards the south. The saint's memory is celebrated towards the end of November by the inhabitants of Avat, who proceed thither in considerable numbers and remain there three days, taking their provisions with them on pack-horses. The shrine is in charge of a sheikh, who generally resides at Avat, but dwells during the days of the festival in a hut in the vicinity of the shrine.

The left bank was bordered by a long, narrow belt of sand-dunes, some of them reaching a considerable height, called Kalmak-kum, another reminder of Mongol occupation. Here two shepherd families were encamped. Beyond Kalmak-kum, to the north-west, there is a poplar wood. In this same part the right bank is called Partscha-kumuschi; and 3 km. to the south-east stands the Kias-gumbes, with a *guristan*. We were here still 12 km. distant from the great desert and the ancient bed of the Jarkent-darja. In this place the river was 24.2 m. broad, its mean depth 2.689 m., its mean velocity 0.3117 m., and its volume 20.28 cub. m., in the second.

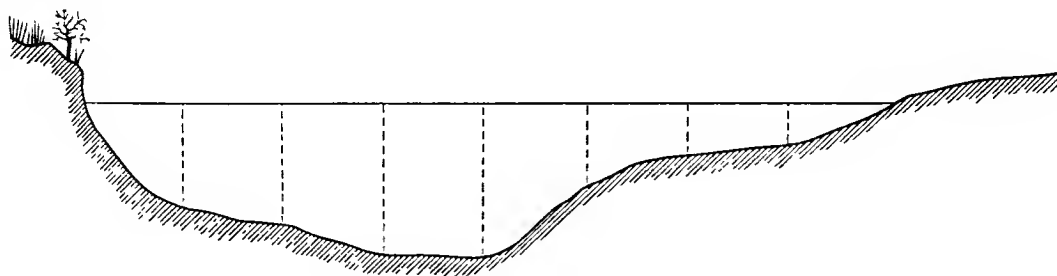
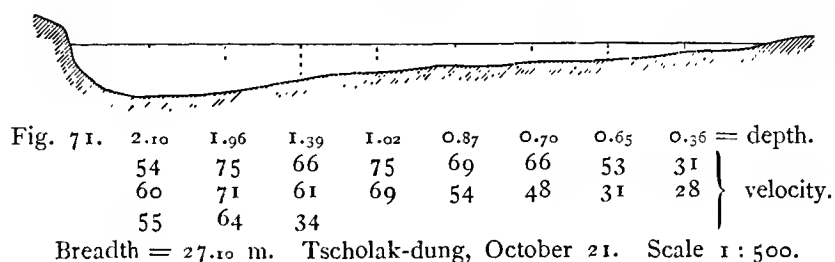


Fig. 70. Left. 3.08 3.69 4.55 4.60 2.50 1.69 1.40 = depth. Right.  
 88 91 40 0 11 — 22 — 11 } velocity.  
 79 88 37 0 18 — 37 — 10 }  
 41 84 30 11 40 — 9 }  
 Breadth = 24.2 m. Kalmak-kum, October 20. Scale 1 : 500.

October 21st. Drop, 0.1 cm.; transparency, 22.5 cm. Immediately below our camp are the two pools of Partscha-kumuschi, in an old bed abandoned years ago, and then, on the left, the district of Sarik-buka-öldi, with the continuation of the Kalmak-kum belt of sand-dunes. Lower down, at a spot where the river sweeps in towards the scarped bank at a sharp angle, the same side of the stream bears the name of Pschujluk. Then for a long distance the river's course is straight, until in fact the solitary, and then unoccupied, hut of Chapa is reached. Here a tiny canal is led off to a patch of cultivated ground. Fastened to the bank was a canoe — strange to say, a very rare object in that part of the river. The next *tschakil*, or »forest-tract», on the left bank is called Topalang. At Härrälik, on the right, we had an unusually distinct view of a loop which was deserted by the river the year before, and in the bottom of it was a deep pool of stagnant water, faithfully preserving the outlines of the loop itself. The last stretches of forest on the left bank are called Kala-sulägä and Tepe-teschdi, and the tract on the right bank, where we encamped at a sharp angle, Tscholak-dung. During the day the river had been tolerably straight, without any wearisome windings. Its channel still remained very broad, although now, in the autumn, only a small fraction of its breadth was covered with water. The remainder was in great part occupied by sedimentary deposits, which in places even bore a little scanty grass. These patches are such as at the period of high flood are only covered by a very shallow layer of water. The course actually pursued by our ferry-boat was the longest it was possible for it to take, for the strongest part of the current, which bore her along, followed the outer circuit or convex periphery of every curve, and between these it crossed the deepest parts of the river-bed diagonally. This however enabled us to obtain a far

more comprehensive view of the configuration and character of the river than if we had studied its topography from the banks. And even our boat-journey would have been attended with considerably greater difficulties, had it been made at the season of high flood.

The road to Avat still continued to touch tangentially the bendings of the river which projected to the left; and on the same side sand-dunes were frequent. Poplar woods alternated with bushes. Everywhere there were old scarped banks, running quite close to the brink of the existing channel. At our camp the breadth was 27.10 m., the mean depth 1.006 m., the mean velocity 0.5496 m., and the volume 14.98 cub. m., in the second, an unprecedented drop in the course of only 24 hours.



October 22nd. The level subsided 0.5 cm.; the transparency was 23.9 cm. at 7 a. m. and 17.9 cm. at 1 p. m. The relative greater limpidity in the morning was due to the fact that the solid particles which the river holds in suspension become more illuminated by the midday sun, and so dim relatively the reflective power of the metal disk which I employed. Possibly the warming of the water during the day also contributed to augment the difference. From Tscholak-dung the river runs for a good distance almost due north-north-east, past the forest country of Jigde-gerem on the right bank. But at K  k-toghrak it makes a gigantic bend to the east, and divides into two branches, of which the one on the left is the shorter and has the swifter current, though at the same time it is more plentifully littered with drift-wood. Between the two branches stretches a broad expanse of generally inundated country, though then partly covered with grass. Here we found ourselves over against Tsch  l-kuduk on the great Ak-su road. After that the stream again flows north-north-east for a considerable space, its channel narrowing perspective to a point in the far distance. On the right is Kum-gerem, with an old dam (*togh*), beside some willows (*sugel*) and poplars of the common variety (*t  r  k*). The district on the left is called K  k-tsch  l, and further on K  t  k-karaul, with an old deserted *karaul*, or »watch-house», on the road to Avat; there too willows are growing. Opposite, on the right bank, is Kuntej-keste. After that the river again bifurcates, passing round a sandy island overgrown with kamisch. The right arm had carved a new path for itself two years before. Next comes, on the left, the district of Hejbulla, and lower down Usun-jurt; while on the right is Kara-tisme. Three kilometers south-east of Usun-jurt is the sand-dune of Ak-dung-dschaj, and another three kilometers farther on in the same direction the now desiccated lake of Tala-k  l, which was originally formed by the Kona-Jarkent-darja. And 15 km. from the river lie the outermost dunes of the great desert; in fact, we found all along, that the Takla-makan was never any great distance from the river. At Usun-jurt we obtained the following

measurements — breadth, 22.86 m.; mean depth, 1.473 m.; mean velocity, 0.5227 m.; volume, 17.60 cub. m. in the second, indicating an appreciable increase since the last measurement. As the vertical sections show, my measurements were always made where the stream was collected into one distinct and regular channel. In proportion as the distance from the mountains, in which the river has its source, increases, the less grows the influence which the daily oscillations of volume have upon the changes of level. Not that the accessions of water from the mountains do not vary from day to day; but, owing to the immense distance they travel, they tend to neutralise one another, and reduce their variations to a constant average. The real factors which do affect the changes of volume in the lower river at the season of autumn are the local pressure of the atmosphere and the contributions of the subterranean springs, drawing upon the irrigation canals in the cultivated tracts north-west of the river's course.

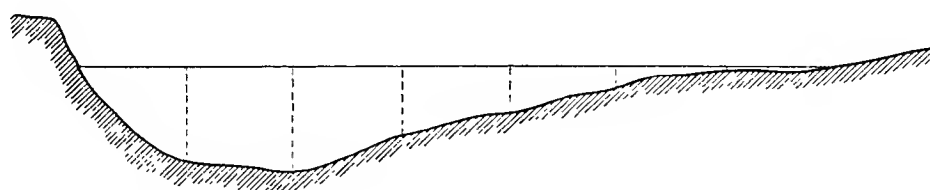


Fig. 72.

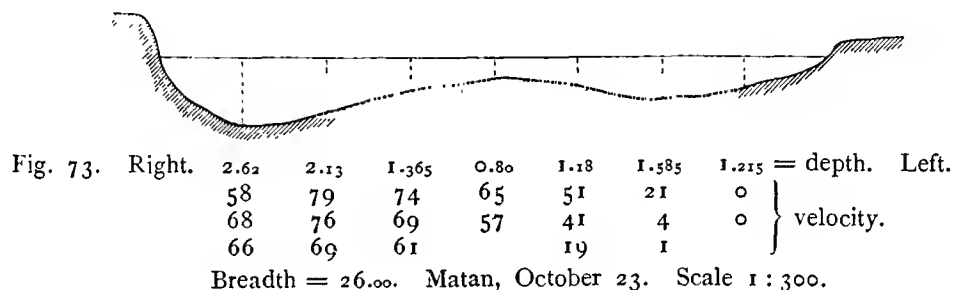
2.96	3.11	2.04	1.48	0.58	0.14 = depth.
60	60	60	55	40	28
60	60	60	53	36	} velocity.
63	52	51	51		

Breadth = 22.86 m. Usun-jurt, October 22. Scale 1 : 500.

October 23rd. The drop = 0.7 cm; the transparency, 15 cm. at 7 a. m., 19 cm. at 1 p. m. The course of the river was here prevaillingly straight; in fact, during the day we only navigated one loop properly so called. The names of the forests and other noteworthy topographical features are Mäsälik on the left, and on the right Tal-satma and Jigde-kotan. Tal-satma is visited by the shepherds; indeed, these people became more frequent, and their huts, occupied or empty, more numerous, in proportion as we approached Avat. Next, at the one large winding of the day, our river was joined from the left by its now dry and overgrown branch, the Kuruk-köbrük, which, as we have already seen, starts at Atschi-dung. Other names are Boghu-baschi on the right and Jaman-dasch on the left, the latter a little way back from the river. Hence it is about 12 km. to Jangi-avat and some 16 km. to Aj-köl-Möl-Anam. At Boghu-baschi an arm issues from the river, which in the height of the summer fills the little lake of Bisch-köl-täräk. Farther to the south-east stands, at a little distance back, an old masar known as Kosch-dung-dschaj. Finally we approached the spot where the Kaschgar-darja, gathering to itself a portion of the water of the Kodaj-darja, bursts, in two channels, through the left bank, and so becomes united with the Jarkent-darja, though the canal Bulak had already come off at Sarat, 3 km. north-west of the confluence. Although now for the greater part choked with sand, mud, and vegetation, the ends of the two channels are quite distinctly marked; indeed both carried water only one year ago, though at the time of our visit there was not a single drop remaining in either of them. After



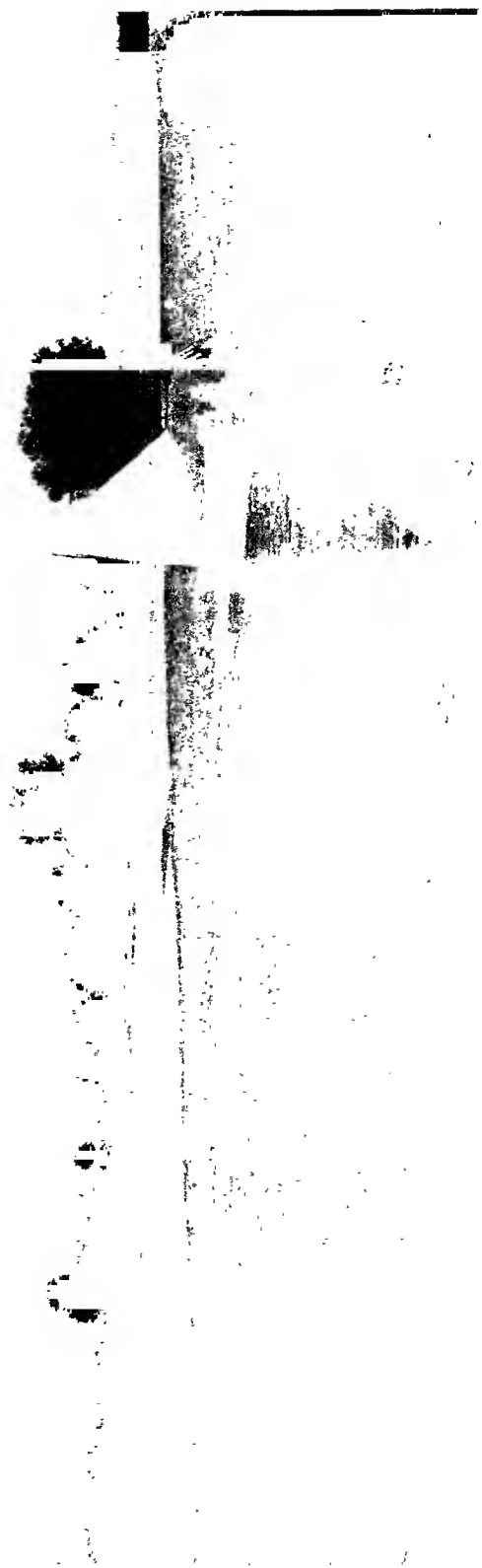
that we passed, on the left, Kum-küjök and, on the right, Matan, a little village consisting of a few clay huts, the first we had seen since we left Lajlik. Here the river is crossed by a mere track leading to Avat, and the inhabitants possess a small ferry-boat, which is used more for transporting sheep from the one side to the other than for the convenience of any traffic there is. Immediately below the village the right bank presents a peculiar and unusual formation, namely the beginning of a fresh channel, which the flood has endeavoured to make for itself during the height of the summer, though without being completely successful. Close in by the right bank there remains a horseshoe-shaped pool, with a sharply outlined promontory, 3 m. high, between itself and the stream. Apart from bushes, tamarisk and other, and steppe plants, the only vegetation consists of thin and infrequent clumps of young toghraks; forest is noticeably wanting. At Matan the river had the following dimensions — breadth, 26.0 m.; mean depth, 1.362 m.; mean velocity, 0.4488 m. per second; volume, 15.89 cub. m. in the second.



Having thus followed the stream to its double confluence with the Kodaj-darja and the Kaschgar-darja, it will perhaps be convenient here to take a general glance at their mutual hydrographical relations. This is however by no means easy, because, in the first place, I had no opportunity of studying with my own eyes the whole of the region which we have necessarily to consider; and in the second place, because the information which the traveller obtains from native guides, hunters, and shepherds is not always to be relied upon, often indeed is the opposite of exact. Still, as everything which is at all calculated to throw light upon a little known region has claims upon our consideration, I will endeavour to present as clearly as possible the results of the intelligence I gleaned about this part of East Turkestan, that is to say, the country lying immediately north-west of the Jarkent-darja between Kuruk-asti and Matan. They may, at any rate, prove useful to some future explorer, although, as I am not in a position to offer an illustrative map, my description must necessarily be somewhat irksome to follow.

The Kara-jilgha-darja (i. e. the Kodaj-darja) begins, as we saw, at Kuruk-asti. At Jussup-Bekning-toghi it sheds off its first arm, which, after skirting on the south the mountain Sultan Kara Sakal Attam, flows east to a lake at Hättim Schah, which is smaller than the Sorun-köl, and is surrounded by pasture-grounds. Between the mountain and the lake lies a belt of barren sand, Akning-kumi, and just south of that a lake, Akning-köli. The latter, however, is overgrown with kamisch, and really resembles a marsh more than a lake, for it is only in summer that it draws water from the Kodaj-darja by a little feeder 1<sup>1</sup>/<sub>2</sub> km. in length.

Pl. 13.



*Lynstr. A. B. Lagrelius & Westphal.*

GROUP OF TOGHRACS ON THE LEFT BANK OF THE JARKENT-DARJA.



Jussup-Bekning-toghi, the place mentioned above, is a dam, which was built in 1892 by Jussup Bek of Maral-baschi. It would appear to be a work of some magnitude, for it is 4 m. broad and  $1\frac{1}{2}$  m. high, and is reported to extend for 15 km., from Jigde-örtäng, the first place where we encamped after leaving Kuruk-asti, northwards to the little lake of Ukarlik-köl, situated beyond the Tömän-tagh, and is said to have taken 2000 men two months to build. Its object is to distribute the waters of the Kodaj-darja through the irrigation canals to the oases, which cannot exist without irrigation.

Leaving the little lake of Hättim Schah on the north, the Kodaj-darja continues its easterly course, through Milka and Kara-gudschek, until it reaches Dugha-dschaji, about 3 km. north of our camp of the same name on the Jarkent-darja. Frequently the forest tracts beside these two streams, which flow so closely parallel to one another, bear identically the same names. At Dugha-dschaji the river again divides. Its right branch, the southern Kodaj-darja, flows through Säsik on to Toghri, where, as we have already seen, it enters the Jarkent-darja. The left or northern branch, called Arpa-akin, goes first to Charman-tala, an uninhabited locality affording some pasture, and then to Kara-buka, where it unites with the other division of the stream which comes from Hättim Schah-köl. This last, meanwhile, has made its way north through the little kamisch-grown marsh of Säsik-köl and the uninhabited forest of Tschong-toghrak, so named from its magnificent poplars, and so on to Kara-buka. Hence the reunited stream proceeds  $1\frac{1}{2}$  km. further to join the Kara-jilgha-darja.

About  $1\frac{1}{2}$  km. before the Kodaj-darja reaches Masar-aldi, and at a spot which is near Kuruk-asti and some 9 km. from the Jarkent-darja, the first-named river sends off the Ak-östäng, which proceeds to the lake of Mukurning-köli, situated close to the west foot of the Sultan Kara Sakal Attam. Then, quitting the lake at its eastern end, it reenters the Kodaj-darja on the south of the Sultan Kara Sakal Attam. This is the second branch of the Kodaj-darja.

The third branch has its beginning (*baschi*) about 10 km. from Kuruk-asti, in the district of Bisch-östäng near Jussup Bekning-toghi, but the great dam forces it to skirt round a northern spur of the Sultan Kara Sakal Attam, called Kallap-tagh; whence it proceeds eastwards, until it joins two other arms of the Kodaj-darja at Ak-dung. After that the stream continues, *viâ* Kargha-lämpäsi and Dung-kotan, to Kemi-sälägä, where, as the name indicates, there is a little ferry-boat or canoe for the use of traffic along the Pitschak-sindi and Tschadir-köl road, which here intersects the river. From Kemi-sälägä the stream flows on to Kötäklik, where it unites with the first and second branches, and then passes through Ilanlik, Jangal-kotan, Kara-tisme, Kälpin-satmasi, Sadet Bekning-lämpäsi to Kalaghatsch-kujlus, where we passed it below Kujluschning-baschi on 17th October.

Immediately north of Bisch-östäng, mentioned above, there is a small burial-place, Kulluk Bajning-gumbesi, crowning a little hill of the same name. The Tschirik-atlandi-östäng, which begins at Jussup Bekning-toghi, after watering the oasis of Tschirik-atlandi, inhabited by half-a-score families, flows eastwards past a little isolated mountain, skirting it on the north, and joins the Kara-jilgha-darja  $1\frac{1}{2}$  km. south of Tschighan-tschöl. It must, however, be a very insignificant rivulet (*arık*), as it is said to carry only sufficient water to turn two mills. An old channel, which

was emptied when Jussup Bek's dam was made, and has been empty ever since, except that occasionally a little water trickles into it from the Tschirik-atlandi-östäng, starts between the Kulluk-tagh and the Tömän-tagh, and, flowing east, unites with the other branches at Tschighan-tschöl. West of the great dam lie the two lakes of Tömän-tagh-köli, which are together no bigger than the Sorun-köl; they begin 6 km. north of Kuruk-asti, and stretch another 6 km. northwards. The water in them is limpid and supports kamisch and marsh-plants.

After shedding off these several branches, the Kodaj-darja flows, first west, then north, of the Tömän-tagh, and bending east enters the Kaschgar-darja at Bisch-köbrük, or the »Five Bridges». The name is derived from five actual arms into which the river is split at the confluence, and each arm carries a bridge on the road coming from Tschighan-tschöl. Of these five branches the one lying farthest south flows eastwards into the Tschighan-tschöl, its water being diverted thither by a dam, a continuation of Jussup Bek's, which obstructs its course just below the bridge that crosses it. Indeed, were it not for this diversion, the Tschighan-tschöl, Tumschuk, Tschadir-köl, Pitschak-sindi, Jaka-kuduk and Suget would all dry up. All these oases are absolutely dependent upon the water which they in this way receive; hence it is easy to understand the importance of the great dam which the people were about to construct at Kuruk-asti, its object being to force the water into the Kodaj-darja, whence it would be distributed by the network of waterways I have described to all the oases in that region. The branch of the Kodaj-darja which traverses the Ukarlik-köl, already mentioned, joins the Kara-jilgha-darja not far from the Tschighan-tschöl. Just below the lake a small *arik* is led off from the stream to turn a mill. Sägislik, a place situated 1½ km. north of Tschighan-tschöl, likewise derives its water from the same stream. \*

From Maral-baschi the Kaschgar-darja flows to Kum-tschakil and Kuruk-täräk, where the country on both sides of it is well cultivated; thence, passing between two inconsiderable heights, the Tschelijä-tagh on the south and the Tschadir-tagh on the north, it continues eastwards past Tschahr-bagh and Okur-tagh (with the tomb Dschaj-kum-masarim) to Küjü-köbrük, where it is crossed by the great Ak-su highway. East of the bridge a portion of the stream makes its way, by means of a miniature channel choked with kamisch, southwards into the lake of Süsük-köl, situated some 1½ km. to the west of the Tömän-tagh. But it does not remain there; leaving the lake on the opposite side, it proceeds to discharge itself into the Kodaj-darja just above Bisch-köl, and so helps to augment the five arms spoken of above. Of these arms the first flows, as already stated, to Tschighan-tschöl, the second to Suget, the third to Pitschak-sindi, the fourth to Jaka-kuduk, and the fifth to Tumschuk. From Küjü-köbrük another arm goes east, and, leaving the Okur-tagh on the left

\* These two villages, Tschighan-tschöl and Sägislik were visited by Pjevtsoff in 1889; but accurate and instructive though his account of his journey is, it throws no fresh light upon the hydrographical relations of this locality. All he says about it is, 'This day [no date given] the expedition travelled along the south-east shores of the marsh [i. e. Lalmoj], along the margin of the virgin forest, passing on the way the small villages of Sigislik and Tschighan-tschon (*sic*), and halted for the night on the bank of an arik which issued from a small lake. Here the marsh of Lalmoj shrunk to a width of 5 versts and contained a great number of tiny lakelets, those to the extreme south-east reaching outside the reed-belts into the open. Life was imparted to the otherwise monotonous depression by the presence of a vast quantity of Natatores and waders' (*Trudij*, etc., p. 67).

hand, enters the lake of Tschahrlik-köl, into which also flow the other four arms and the Kodaj-darja. Issuing from this lake again, the river travels to the Tumschuk-tag, and a little way south of Tumschuk is crossed by the bridge of Telejmet-köbrügi on the road between Tschighan-tschöl and Tumschuk. Two or three kilometers below the bridge the river flows into the lake of Gullik-köl, north of which lies Ak-tam, and then some 6 km. lower down empties itself into the lake of Lalmoj, which is shown on Pjevtsoff's map. A few kilometers south of this lake stands the masar of Dschaj-toghrak-ikki-dschan-Pena-Chodschan. Issuing, again, from Lalmoj, the river flows north to the dam of Jigde-togh, and from it two *östäng* (canals) are led off, to water the inhabited tracts (*ajmaks*) of Kumluk and Pitschak-sindi, both on the right-hand side of the river. Altogether, four canals start at the dam, and irrigate four separate localities, after which their surplus water returns again to the main stream. Continuing beyond the dam, the river touches Tschadir-köl, on the left, and Jaka-kuduk, then flows east to Konaghlik, turns north to Suget, east again to Kum-kätschik, once more north to Tschong-köl, a forest tract with a lake, and so east to Kara-köl, Basch-aktschi, and Dutschin or Dötschun. This last stands on the former road which linked together Kengrak, Dung-sarat, Ottus-kemi, Jirinde, and finally Dutschin, the last three being all old road-stations. But while Ottus-kemi belongs to the province of Jarkent, Jirinde belongs to Ak-su. The next places the river touches are Buja-tägisch and Palas-japti, two forest regions, then Jangi-avat, or rather it passes this last 6 km. to the south. Next come Kara-kirtschin, Tschadir-köl, where the masar and burial-place of Sarati stand on the left bank, Jaman-darschi, on the right, and Kum-küjü; and finally it effects a junction with the Jarkent-darja. At Tschadir-köl a bifurcation takes place, in that a branch goes off to the north, turns east, passes through the lakes of Bulak and Ukarlik-köl, and finally enters the Jarkent-darja at At-öldi.

The following enumeration embraces all the stations between Maral-baschi and Ak-su: — Maral-baschi, Tschahr-bagh, Tumschuk, Tschadir-köl, Jaka-kuduk, Suget, Dschajde-lenger (on the boundary between the provinces of Jarkent and Ak-su), Tschilan, Tschöl-kuduk, Saj-lenger (*lenger* = station-house), Aj-köl-Möl-Annam-Chodschan (masar), Kona-darja (with bridge), Kuba-örtäng, Bisch-arik-lenger, Jangi-darja, Schachtäng (lenger), Tolan-östäng (with bridge), Jangi-schahr, Asuk-lengeri, Tumkara (a gumbes on the left-hand side of the road), Kirisch, and Kirgis-Häkimi-lenger. Here the road divides, the left branch going to the gate of Subuntschi-därvase, the right branch to Jirintschi, to several of the outlying villages of Ak-su, and finally to the Kona-schahr-kum-därvase, or Sand Gate in the Old Town, i. e. the Mussulman quarter, of Ak-su.

It is estimated that between Maral-baschi and Matan 700 *ujlik* or »families», i. e. homesteads, are supplied with water by the Kodaj-darja, and 1,700 homesteads by the Kaschgar-darja. Hence the irrigated region I have described above is inhabited by 10,000 to 12,000 persons. On the other hand, the Jarkent-darja, notwithstanding that it is the principal stream of the country, passes through an extremely sparsely inhabited region. Between Kuruk-asti and Matan there were said to be only 45 shepherds' *ujlik*, and these men generally leave their wives and children behind them in the neighbouring villages. Hence it is not surprising, that for long distances together we found the river-side entirely uninhabited. Most of

these shepherds are employed by *bajs*, that is rich men or merchants, and each flock has its own appointed grazing-grounds, beyond which it is not permitted to wander. Except at Kuruk-asti and Sorun, there are no fixed settlements, the shepherds' huts (*satmas*) in other places being very slight structures, meant for temporary occupation only.

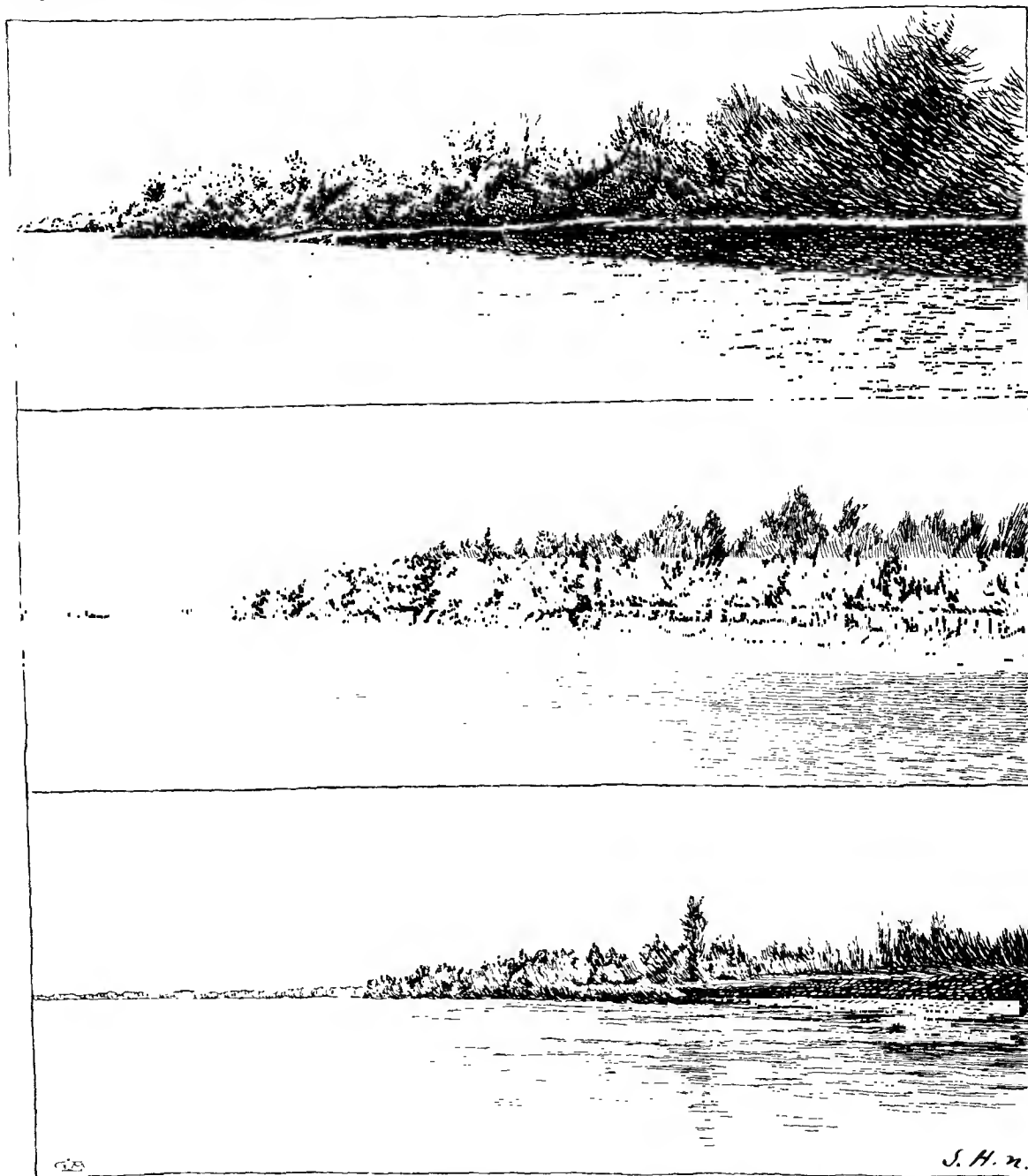


Fig. 74. SCENERY ON THE BANKS OF THE LOWER JARKENT-DARJA.

The law or custom, known as *no:ot*, which determines the order in which the several villages shall enjoy a free supply of irrigation water, as well as the period of time they shall be entitled to its usufruct, has hitherto scarcely ever been put

into force, because of the copious supplies furnished by the Kodaj-darja. But since the river has begun to carry a smaller volume, it has been necessary to apply it: for instance, Pitschak-sindi is restricted to a 25 days' supply, and the water is then cut off, otherwise the other villages in the neighbourhood would come short. The Chinese leave the administration of this important law in the hands of a native *mirab*, who dwells at Tschighan-tschöl. But the way in which the office is administered gives occasion to endless bickerings and incessant complaints to the Chinese authorities. Indeed, a large percentage of the litigation which comes before the Chinese *ambans* for settlement in East Turkestan consists of irrigation disputes, occasioned in great part by the corruption of the native officials, who constantly accept bribes from this or the other village anxious to prolong unduly the period during which it is lawfully entitled to receive water for irrigating its fields.

Between the Kaschgar-darja and the Kodaj-darja there exist but small patches of sandy desert.\* Steppe and thin forest are quite common, the latter in places dead and withered. Apart from these, the intervening country consists of fine clay, bare, hard, and level. In the region which stretches to the north of the Jarkent-darja, and which I have endeavoured to describe above, drift-sand occurs only sporadically at a few places, such as Ak-kum, Dugha-dschaji, Säsik-jarsik, Toghri-kum, Kalmak-kum, Nakara-chane, Atschi-dung, Kötäk-köl, and Kuruk-köbrük. There is a pretty long belt of sand, some 6 km. wide, at Ottus-kemi, south of the Kaschgar-darja. A small patch of sand called Kasch-kum extends west of Avat. South of the great Ak-su highway there lies a larger expanse, called Kaplämä-kum, between the stations of Tschöl-kuduk and Saj-arik. The little patches of sand which we observed on the left bank of the Jarkent-darja are not detached outliers of any great accumulation, but merely isolated gatherings separated from one another by thin poplar woods, tamarisk steppe, underwoods, or kamisch-beds. And the same thing is true of the greater part of the sandy spots which we noticed on the right bank: most of them are isolated, only a few have direct connection with the great desert of East Turkestan.

The map which accompanied my monograph in *Petermanns Mitteilungen* (Ergänzungsheft No. 131) contains only a certain number of the names which I have had occasion to mention above, and what do appear there are mostly those of places situated on the great Ak-su highway. In fact, the region as a whole is unknown, except for the small part of it traversed by Pjevtsoff. No European traveller has ever visited it. Equally unknown, before this journey of mine, was the section of the Jarkent-darja between the Masar-tagh and the confluence of the Chotan-darja: it had never previously been surveyed. Hence a comparison between the map which accompanies these volumes and all previously existing maps of this section of the river will show great, and not unexpected, differences.

But the fact which is of especial interest, in the oral information which I have communicated above about the country that lies between the Kaschgar-darja and the Jarkent-darja,<sup>†</sup> is that it is by no means the sandy desert it has hitherto been

\* What the connections between these two rivers are has not yet been made out, so that I am unable to state whether they do actually possess separate and independent beds, or whether they do not rather intermingle their waters in the marsh I have spoken of. Pjevtsoff says distinctly, that the lake of Lalmoj receives water from the Kaschgar-darja as well as from the Jarkent-darja, and in this he may very well be correct.





Fig. 75. FOREST SCENERY ON THE BANK OF THE LOWER JARKENT-DARJA.

supposed to be; but, on the contrary, is cut up by a perfect reticulation of irrigation canals, rivers, and old watercourses, divided and subdivided again and again. It is, in fact, a region traversed in every direction by waterways, natural or artificial. As a consequence, the country is to no small extent inhabited and cultivated, and possesses settled villages and flocks of sheep; so that its predominating features are agriculture and sheep-breeding rather than drift-sand.

The general slope of the country is in the fullest sense of the word slight, as is proved partly by the leisurely and meandering course of the Jarkent-darja, and partly by the great number of abandoned channels which we have noticed. It is only in a region that is almost at a dead level that a river can alter its bed as often as the Jarkent-darja does, so that scarce a year passes without some part of the river-bed being destroyed and the neck of some winding (loop) or other being cut through. The numerous extremely shallow lakes, overgrown with reeds, also indicate that this is one of the flattest, levellest tracts throughout the whole of this river basin. It is not until we come to the lowest part of the Tarim system, that we find anything to compare with this pronounced lacustrine region. Indeed there is a close resemblance between the terminus of the Kaschgar-darja and the terminus of the Tarim in respect of the great number of lakes that occur within a limited area. In the latter region we shall find, though on a scale of quite different magnitude, the same phenomena of shifting river-beds and wandering lakes. But to this subject we shall return again lower down.

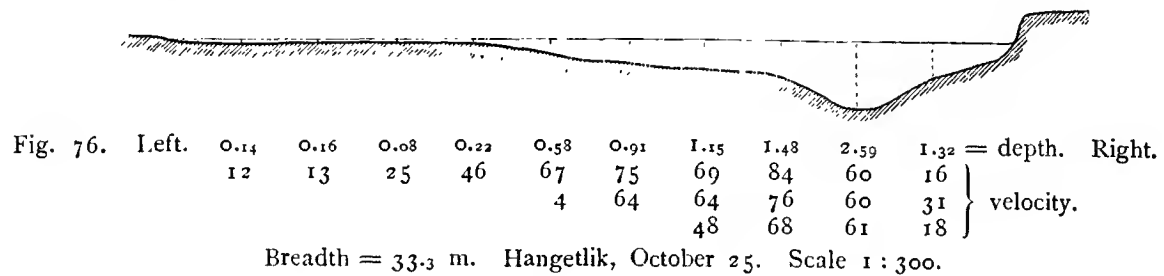
October 25th. During the last 43 hours the river only dropped 1.65 cm. The transparency amounted at 7 a. m. to 23.6 cm. and at 1 p. m. to 19.4 cm. At Matan the scarped banks were 2.84 m. high. This place consisted of five homesteads or families, who, besides owning 30 sheep and 12 cows, grow wheat and barley at Bisch-täräk-köl. These people call the great desert to the south Terkerken, and report that it is 40 km. to the high barren sand-dunes. A short distance from the right bank lies the lake of Tala-köl, or Desert Lake. It may be worth mentioning, that the road from Matan to Avat traverses the *beklik* or »beg's district» of Goro-tschöl, which embraces some 700 families, and Ara-gerem, a village which is immediately subject to Avat. Between Matan and Ak-su the road touches, or crosses, or passes through the following: — the village of Üjme, a *kona-darja* or old river-bed, the villages of Kum-arik, Telve, Kum-basch, and Topluk, the masar of Kuschtsche-gumbesi, the *lenger*, or »station»-house, of Bisch-arik, situated on the main high-road, Ibrahim Häkim-lengeri, Jangi-darja (an arm of the Ak-su-darja), Tolan-köbrügi, and finally Jangi-schahr, the Chinese quarter of Ak-su. In the spring timber is generally floated down to Ak-su from the forests higher up the stream. It was on the basis of experience gained in that connection that our guide was able to estimate the time we should take to drift down to Avat.

At Matan it was expected that, in accordance with its usual practice, the river would begin to rise in about ten days, or early in November; for it is then that the overflow from the irrigation canals begins to make its presence felt, through the subterranean springs and watercourses, in the Jarkent-darja. The river here would begin to freeze, I was told, in about 40 or 50 days, but it would be two months before the Ak-su-darja froze; for, owing to its greater velocity, it is always at least ten days behind the slower-moving Jarkent-darja in feeling the full effects of the frost. The forests in this locality harbour stags, antelopes, roe-deer, wild-boar, hares, lynxes, pheasants, and various other varieties of game, though the tiger is said not to show himself there. None of the natives had ever seen a wild camel in this neighbourhood; whence it would almost seem as though this special inhabitant of the desert never ventured to approach the streams of the Tarim system. The only spot where the wild camel occurs in any numbers is around the point where the Kerija-darja finally becomes lost in the sand.

The Jarkent-darja still preserved its specific peculiarities, though the bends were not particularly sharp. Almost everywhere the high-water banks were plainly distinguishable, and the actual current meandered zigzag backwards and forwards from side to side of the river-bed, though its edges were often masked by steppe vegetation and underwoods. During the day we passed five abandoned loops, containing pools and islands. The local name for these small lagoons of stagnant water is *darja-taschkan-köl*, i. e. »lake which the river has flung away». Sometimes, in addition to the usual kamisch, the alluvial deposits next the convex parts of the banks, are also diversified by sand-dunes. In all probability these are spots which escape inundation at high water, otherwise the stream would wash the sand away before it had time to accumulate. Besides, those parts of the river-bed which are destitute of both vegetation and drift-sand bear unmistakable signs of having been under water. As a general rule, at the period of full flood the river-bed is brimming full from bank to bank.

Steppe and underwoods were the predominant forms of vegetation passed during the day; we only observed full-grown poplars at a single bend, and they were few in number. The names of the local topography are — on the right, Paschalik, with a pasture-ground to the south of it called Kara-toghrak; and, on the left, Pachma-masar, a small cemetery, with the usual poles and streamers, embowered in a clump of poplars, beside a loop of the river that was abandoned two years ago. That water had flowed round this loop at a quite recent date was evidenced by the naked condition of its bed; for loops which have been abandoned any length of time are generally overgrown with vegetation, often indeed smothered under young forest, reeds, and bushes. Then, on the right bank, we had Jar-kotan. At Jamal-tüschi there are two small loops quite close together, each containing the usual lagoon. Another winding of precisely similar character occurs at Kan-toghrighi, or the »Kings' Poplar»; and there also dwelt a shepherd family beside a masar bearing the same name. Upon reaching Kodajlik, we were about 46 km. from the bazar of Bisch-arik and 60 km. from Kuba-örtäng, a place on the great Ak-su highway, one stage from Ak-su. These off-hand estimates of distance which the natives give are of course by no means trustworthy; at most, they are approximations only. According to my previous map, the distance between Kodajlik and Bisch-arik is indeed 46 km., but the exact agreement between the two can only be set down as a pure coincidence.

At our camp at Hangetlik the river gave the following measurements: breadth, 33.3 m.; mean depth, 0.785 m.; mean velocity, 0.5026 m. per second; and volume, 13.13 cub. m. in the second.



Close to the foot of every alluvial peninsula it was now an almost invariable thing to find a pool of deep, clear water, resembling in shape a sharpened lozenge or scimitar-blade with its point directed up-stream. The bottom of these pools consist of extremely fine, soft mud, every whit as dangerous as quick-sand; indeed, it was almost equally dangerous to venture upon the exposed ground which edges them round. It is in such places that counter-currents are set up, or that the water, getting cut off, becomes stationary, whereupon the finer sedimentary matter which it holds in suspension begins to settle to the bottom. On the other hand, where the river moves swiftly, the sedimentary matter is invariably swept on along with the current, and so gets no opportunity to settle. Across the throat of each of these lagoons there is always a sort of threshold or ridge, generally exposed or else close under the surface. At our camp the containing banks were 2.73 m. high, and the last high-water had risen 1.49 m. above the level of the day of our visit.

October 26th. The drop in 9 hours amounted to 0.7 cm. The transparency was 17.8 cm. at 7 a. m. and 16.8 cm. at 1 p. m. The reason of the decrease in the latter *datum*, or in other words the reason of the river becoming more turbid, was that it was now passing through clay, and consequently held the finer particles of matter a longer time in suspension than when it travelled amongst sand. Hitherto it had steered a steady east-north-east course; and, though rather sinuous, was nothing like so serpentine as in the region below the Masar-tagh. Bushes and kamisch were the predominant forms of vegetation; young poplars occurred in small clumps at great distances apart. The first district we passed on the left was Kök-ajak. At Jigde-kotan, on the right bank, there was a loop, more like an expansion of the river-bed than anything else, which became deserted three years previously, and still embraced a large kamisch island. Next, at At-öldi, on the left bank, came a small clump of poplars (*toghrak* and *türäk*), like an oasis in the dead level of the kamisch steppe. It sheltered a hut, and in the bed of a dried-up lake close by wheat is grown, on ground irrigated by a little canal drawn off from the river. With an energetic and clear-sighted government there should surely be no difficulty in devising and carrying out a widely ramifying system of irrigation on both sides of the Jarkent-darja and Tarim, and so conferring fertility, and its concomitant, prosperity, upon many square kilometers of this now rather neglected province. The agriculture which is carried on in the immediate vicinity of the river is altogether insignificant; the most the shepherds do is to grow just sufficient for their own domestic use.\* As a rule, the ground chosen for cultivation is generally the bottom of a desiccated lake or marsh which has recently been under water; the old watercourse which fed the lake or marsh being utilized as an irrigation-channel to carry water to the crops.

The third arm of the Kaschgar-darja enters the Jarkent-darja at At-öldi, though it is very rare indeed that it contributes even a small quantity of water to the latter. As a rule, it resolves itself into a chain of small lagoons or pools, which are only filled in the season of high flood. The largest of these, and the one which retains water even when all the others have dried up, is Bulak. Farther on, on the same side of the river, is the forest-tract of Tschakan; and on the right Tulumischtan, a place inhabited by a shepherd's family, who own a canoe, and grow wheat in the bed of an old desiccated lake. Seven kilometers south of Jolbars-äsildi there is said to be a masar called Mejim Kuli Busrugvar. On the left of the river we next observed a satma at Schupurluk; and 9 km. north of it is the large and greatly venerated masar of Imam Bet Ali Ghasim, with several »oratories», and a village of 20 to 30 families and several schejks. This masar is estimated to be 18 potaj from Schupurluk, so that, on this reckoning, the last-named must be 97 km. from Ak-su. According to my first map, the same route measures 88 km. At Kök-akin, on the right, our stream is joined by the old branch which starts

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\* Not that the Chinese authorities are absolutely supine and indifferent to the possibilities of improvement, both in agriculture and in irrigation. Goro-tschöl, mentioned above, is a so-called *jangi-jurt*, that is to say a new settlement or colony, founded by command of the Chinese authorities; it was made about two years after the Chinese occupation of East Turkestan. We shall come across two or three similar »colonies» lower down.

at Kum-ägis, and which is here so choked with underwood and young forest that I should never have observed it, had not my attention been expressly directed to it. At Jesi-köl we found two shepherds and their families in charge of 500 sheep; they grow wheat in the bed of a lake which dried up ten years ago; and there is a still older lake farther to the south. The country between this place and Avat is estimated to count 7 shepherds' encampments, with the same number of *partscha-koj*, or »sheepfolds», likewise known as *aghil*. Between Avat and the mouth of the Chotan-darja there are said to be 8 such sheepfolds on the right bank and 5 on the left. The flockmasters all dwell in Avat.

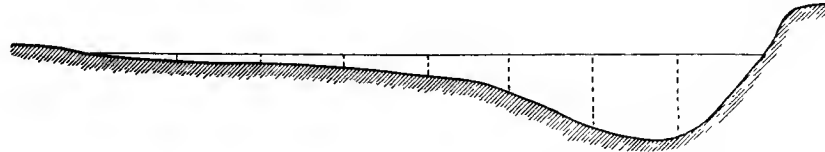


Fig. 77. Left. 

0.26	0.38	0.46	0.79	1.47	2.81	3.14
19	22	35	56	65	68	48
	22	31	37	65	68	51
				40	61	52

 = depth. Right. } velocity.

Breadth = 26.2 m. Jesi-köl, October 26. Scale 1 : 300.

At Jesi-köl the breadth amounted to 26.2 m., the mean depth to 1.164 m., the mean velocity to 0.4906 m. per second, and the volume to 14.96 cub. m. in the second. Thus the river was steadily decreasing in volume. The quantity of water at this part of its course depends in autumn upon the amount contributed by the Pamirs and the mountains of western Tibet, and that again depends upon the amount of the precipitation and the meteorological conditions prevailing there. Heavy falls of snow in winter always give rise to a considerably swollen stream. When the summer is bright and sunny, the snow melts rapidly; and even when it is cloudy and rainy, there is always a full river. On the other hand, when the snowfall in winter is only slight, the volume of the river is relatively small. Here too, as higher up, the quantity of water is to some extent dependent upon the pressure of the atmosphere; and also — this applies with especial force to this particular part of the Jarkent-darja — to the subterranean contributories returning from the canals and fields. After the latter have been supplied with as much irrigation water as they need, the canals which carry it to them are left open, so that the water is free to run off, and eventually it finds its way back to the river again.

October 27th. Drop = 0.8 cm.; the transparency, 18.8 at 7 a. m. and 16.3 at 1 p. m. The scarped banks were 2.05 m. high, and the high-water level was 1.17 m. above the then existing level of the current. The river still continued to wind backwards and forwards. At first the velocity was normal, but it gradually decreased as we drew near to the Ak-su-darja, until at the confluence the stream was quite stationary. Steppe and bush vegetation still held sway on the banks. It was a perfectly still day, without a breath of wind, and the river glittered like a mirror, the only thing which ruffled its metallic smoothness being a few faint ripples in the actual current. As we advanced the river-bed contracted more and more. On the left a canal was led off to Kurme, the home of a shepherd family.

At this same spot the river divided for a short distance into two arms; and whilst the right-hand arm described a curious double loop, the left-hand one took a short cut. The latter, though now dry, had nevertheless contained water in the summer. It was at the big loop that Jesi-köl was situated; and here again there were two shepherds who grew some wheat, while their huts were embowered in *täräks* and *toghraks*. *Jughas-basch-bulung*, where there were reported to be two abandoned loops hidden in the forest, was yet another such shepherd encampment; and a very similar description would apply to *Kapkaktschi* on the right bank. Here we were 11 km. south of an old bed of the *Ak-su-darja*. Below this point the country is called *Tschong-aral*, or the »Big Island», that is to say, this is the name given to the tract which lies in the angle between the two rapidly converging rivers, the *Jarkent-darja* and the *Ak-su-darja*. Here the containing banks were in places  $3\frac{1}{2}$  m. high. On the right was the loop of *Usun-ägin*, which was destroyed seven years previously. Here was a little cultivation again at the homestead of *Jing-pang*, some distance back from the left bank. Just below this spot the river makes a sharp bend, and the neck of land at its »root» bids fair to be cut through very soon, for there was a tiny rivulet already running across it, and a little pool had established itself at the narrowest part of the isthmus. The vertical faces of the immediately following bends were white with salt crystals, formed from the salt which oozes out of the adjacent highly saliferous ground. The riparian vegetation consists of *tamarisks* and reeds, with scattered *poplars*. In this locality the high-water level was only 80 cm. above the existing level. The river-bed, which in virtue of the great regularity of its formation resembles an artificial canal, was 50 m. broad, and the depth as much as 6 m.; consequently the stream was extremely sluggish. On the right bank stood the unoccupied homestead of *Rehim Jol Begi*, with a canoe; and from that point we caught our first distinct view of the broad bosom of the *Ak-su-darja*.

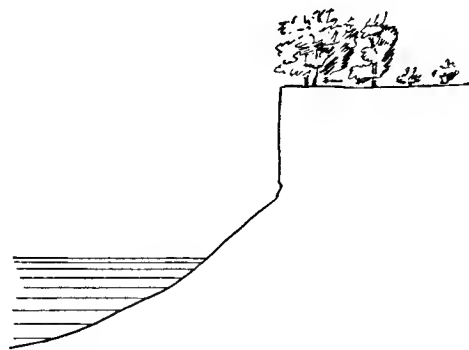


Fig. 78. THE RIGHT BANK OF JARKENT-DARJA A LITTLE ABOVE AK-SU-DARJA.

## CHAPTER V.

### HYDROGRAPHIC RELATIONS OF THE JARKENT-DARJA AND THE AK-SU-DARJA.

Shortly before the actual confluence the Jarkent-darja makes an unexpected turn to the north-west. At the same spot the Ak-su-darja, although its general course is south-east, flows to the east-north-east; then, bending suddenly south to within a few hundred meters of the Jarkent-darja, it approaches the actual confluence from the west-south-west. It seems likely, that this southward bend will, under the pressure of the water behind it, advance still farther in the same direction, so that eventually the confluence of the two streams will probably take place higher up the Jarkent-darja. From the point of junction, the united stream, which henceforward may be called the Tarim, preserves the dominant direction of the Ak-su-darja, that is towards the east-north-east, without being in the slightest degree diverted or affected by the sister stream. In fact, the Jarkent-darja, notwithstanding the considerable volume it carries in the summer, has not been able to form a single loop towards the north. This circumstance alone would justify the supposition, that the Ak-su-darja is the more powerful stream of the two. Indeed, the natives had all along asserted, that at all seasons of the year the Ak-su-darja has a bigger flood than the Jarkent-darja. When on 30th May 1895 I crossed over the latter a little above the confluence, I was amazed to find that, imposing stream though it was at the city of Jarkent, its volume at the crossing measured no more than 7.5 cub. m. in the second. Now on October 26th we obtained a volume of 14.96 cub. m., or precisely twice as much. The period of high water falls exactly between these two dates; and 7.5 cub. m. may be regarded as the spring minimum, for the various dams have then already begun to divert the bulk of the stream into the canals of Maral-baschi, and the double volume of 14 to 15 cub. m. as the minimum for the autumn, for, as I have already said, it was expected that the river would soon begin to rise again in consequence of the re-entry of the water from the irrigation canals. The dams, it is true, are the means of draining enormous quantities of water away from

the river; but in spite of that, we found, when the stream was at its lowest, that the maximum flood-level was about one meter higher than the actual level at the end of October. And the next measurement we made showed, that the Ak-su-darja is almost five times as big a stream as the Jarkent-darja at the confluence of the two. I have no doubt that the same relative proportions are maintained at the period of maximum flood, though it would require a fresh measurement at that season to make the matter absolutely certain. Indeed, I can readily conceive, that the difference between the two streams is, if anything, greater in July and August than it is in October, for the sources of the Jarkent-darja are very much more distant than those of the Ak-su-darja, so that the maximum flood of the former must reach the point of confluence considerably later than the maximum flood of the shorter stream, the Ak-su-darja. In other words, the maximum floods of the two rivers do not reach the confluence simultaneously: that of the Ak-su-darja arrives earlier than the flood of its sister-stream, owing to the fact that its feeders in the Tien-schan are very much nearer the confluence than the feeders of the Jarkent-darja in the Kwen-lun.\* In a similar way, once its highest point is attained, the Ak-su-darja, no doubt, begins to fall before the Jarkent-darja does, so that by the end of October the subsidence of the former is more advanced than the subsidence of the latter, and yet we ascertained that the Jarkent-darja is only one-fifth as big as the Ak-su-darja. In the early summer of 1895 I found an even greater difference than this: for instance, on 2nd June, the Ak-su-darja measured 69.3 cub. m. in the second or approximately ten times as much water as there was in the Jarkent-darja. On the strength of these data there is reason to suppose, that the Ak-su-darja is absolutely the larger stream at all seasons of the year. If however the distance from the point where each

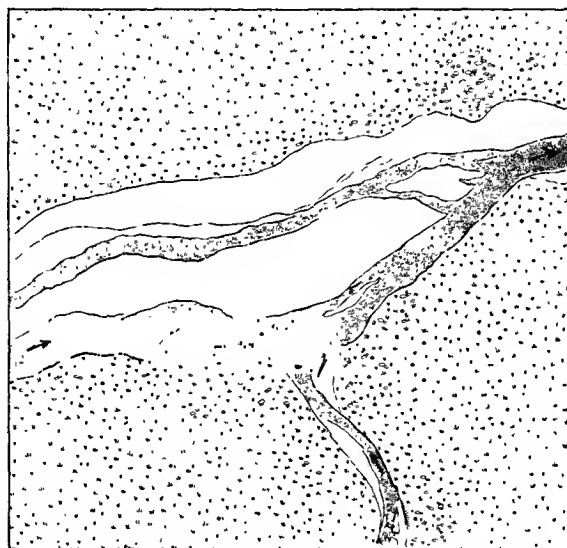


Fig. 79. CONFLUENCE OF JARKENT- AND AK-SU-DARJA.

\* A man, who apparently possessed an intimate knowledge of that part of the country, gave me information of a different tenor. He asserted, that the Ak-su-darja attains its highest level in the end of August, and that the full-flood period only lasts a week. The flood water of the Jarkent-darja arrives, he said, ten to fifteen days earlier, and the flood-water of the Chotan-darja in the end of July or beginning of August, that is to say, coincidently with the flood-water of the Jarkent-darja, and so considerably earlier than the flood of the Ak-su-darja. It is of course quite impossible to lay down any law in this case, the circumstances being to such a great extent dependent upon climatic conditions. On the one hand, the basin of the Jarkent-darja, and especially the gathering-grounds of its sources, are situated at a more southerly latitude than those of the Ak-su-darja. On the other hand, the gathering-grounds of the latter are probably more directly exposed to the power of the midday sun. Besides, the thermometric conditions over the regions in which the two streams originate respectively vary from year to year. A cold summer at the head-waters of the Jarkent-darja will retard the date of its maximum flood, while at the same time the conditions in the head-water region of the Ak-su-darja may perhaps favour a rapid melting of the snow. Hence it is impossible to lay down any regular and uniform law with regard to this matter, especially as the region as a whole is so little known, and continuous observations extending over a prolonged period are altogether wanting.



river breaks out of the mountains to their common confluence were the same for both, and if the regions which the Jarkent-darja flows through were as thinly populated as those which the Ak-su-darja flows through, and if, again, the Jarkent-darja were not drained to the enormous extent it is by the irrigation-canals to Maral-baschi, probably this stream would be at any rate as big and as powerful as the Ak-su-darja. It is thus to these secondary or contributory circumstances that the *de facto* relations of the two rivers are in the main due. And here the question is suggested, Which of these two rivers is to be regarded as the principal stream of East Turkestan? Not that the answer is of any very special importance; it is, in fact, more or less a matter of taste, which admits of settlement in two different ways. If the principal stream is the one which is longest, then the honour of being the premier river of East Turkestan belongs unquestionably to the Jarkent-darja; but if, on the other hand, we say that the principal stream is the one which carries the greater volume, then it is evident that the distinction goes to the Ak-su-darja. During my first journey I had the opportunity of studying the Jarkent-darja in several parts of its upper waters, where its primary tributaries collect, and I had no doubt whatever about the matter, but, with Bogdanovitsch, regarded that river as the main hydrographic artery of East Turkestan. The distance between its remotest source near the Kara-korum Pass to Jarkent-darjaning-kujluschi, its confluence with the Ak-su-darja, amounts to 1090 km., whereas the distance of the Ak-su-darja from *its* source to the confluence is only 500 km., or, adding thereto the length of its tributary the Toshkan-darja, 640 km. Further, the natives apply to the united stream the name of Jarkent-darja all the way to Abdal, where its waters are dissipated through the marshes. On the other hand, the name Ak-su-darja is never used in the lower course of the river, though it is used, and used to the exclusion of every other name, immediately below the confluence. The name *Jarkent-darjaning-kujluschi* or *-küjlüschi* is not without significance: it means the place where the »Jarkent-darja empties itself«. If the Ak-su-darja were regarded as the tributary, the name of the confluence would be Ak-su-darjaning-küjlüschi. This shows clearly, that the natives who dwell in the vicinity of the confluence entertain no doubt whatever as to which is the mother stream (viz. the Ak-su-darja) and which the contributory (the Jarkent-darja); and in these matters the natives frequently display a remarkable instinct. The reason why the people in the Lop country call the river the Jarkent-darja, and not the Ak-su-darja, is altogether alien to hydrographic considerations; they call it so simply because the city of Jarkent is more famous, and consequently better known to them, than the town of Ak-su. The drainage-basin of the Jarkent-darja is, however, more extensive than that of the sister-stream, measuring 64,000  $\square$  km., as compared with 42,000  $\square$  km. for the basin of the Ak-su-darja. Seeing, then, that in respect of both length and drainage-area, the Jarkent-darja has the advantage over the Ak-su-darja, the former may well be accepted as the chief river of East Turkestan.

Strictly speaking, that river ought to be regarded as the principal stream of the country which shows the higher flood-mean throughout the year. Were the Jarkent-darja dependent upon its own volume alone, it would have difficulty in getting all the way to Abdal; on the other hand, the Tarim would certainly reach that point even though it were not joined by the Jarkent-darja, though in that case the

Lake of Kara-koschun would probably disappear. Heavy contributions are levied upon all the rivers of East Turkestan the moment they emerge from the mountains, in that the oases, which girdle the outer periphery of the lowland parts of their basin, deprive them of very considerable quantities of water, so that, as they radiate across the arid regions towards their point of convergence in the Lop marshes, they shrink in a more than proportional degree. The stream which suffers least from these antagonistic influences is the Ak-su-darja. On the assumption that this river is the main trunk of the hydrographic system, and the Jarkent-darja, Chotan-darja, Kerija-darja, and Nija-darja are its chief branches, it is interesting to note how these streams become severally smaller the farther they lie to the east; and this applies to the area of their drainage no less than to their length and their volume. The Jarkent-darja, when it joins with the Ak-su-darja, is, in spite of its losses on the way, a really imposing stream; the Chotan-darja, however, only flows into the Jarkent-darja during forty days throughout the year; while the Kerija-darja perishes in the sand fully 132 km. before reaching the Atschik-darja, a branch of the Tarim,\* and the Nija-darja disappears at a distance of no less than 280 km. from the Tarim. The only exception to this rule is the Tschertschen-darja, which carries water all the year round. The causes of this are, however, the great extent of its drainage area in Northern Tibet, its own geographical position, and the climatic conditions which prevail within its basin.

If a stranger, ignorant of the hydrographic peculiarities of the region, were to arrive at the Jarkent-darjaning-kujluschi, no matter what the season of the year, he would not hesitate for a single instant as to which of the two rivers that meet there is the mother stream and which the tributary; and a glance at the accompanying sketch-map (p. 77) is equally conclusive. However for the future we shall continue to treat the Jarkent-darja as the principal stream of the Tarim system.

Returning now to the Jarkent-darjaning-kujluschi — a short distance above the actual confluence the Jarkent-darja contracts to a very narrow canal-like stream, with quite insignificant alluvial deposits. At the apex between the two converging rivers there is a crescentic deposit of sedimentary matter. During the last few hundred metres or so of its course the current comes to a complete standstill, and

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\* This was the measurement I ascertained when in 1895 I traversed the Kerija-darja from Kotschkar-aghil to its termination, though from the point where the water ceased to flow it was possible to follow its sanded-up bed for another 1½ days. After that it disappeared under sand-dunes 30 m. high, and its further course could only be surmised from the poplars and tamarisks which survived at intervals along a pretty straight line towards the north. Dr. M. A. Stein, when describing his visit to the ruins of Kara-dung, which I discovered in 1895, makes the following interesting statements: »A remark of Mirza Hajdar, the Moghul leader and historian, makes it very probable, that the Kerija River reached the Tarim as late as the 16th century. Its old course across the desert can be followed even now without serious difficulty, and certainly forms the most direct route between Khotan and the ancient settlements of Kucha and further north-east. Kara-dong lies about half-way between the Tarim and the line of oases stretching to the east of Khotan, and a small post established here would have answered the purpose of guarding the route and protecting the approaches from the northern region» (*Sand-buried Ruins of Khotan*, p. 432).

The Kerija was cut off from the Tarim by a gradual process, receding from it step by step; indeed, the process is still going on, for the distance between the northernmost tentacle of the former and the great river is constantly increasing, though at a slow rate. And although the old channel of the Kerija-darja is now obliterated or filled in with sand, it is not only possible, it is indeed quite probable, judging from the still living poplars, that it did reach the Tarim as late as the 16th century.

when it strikes the Ak-su-darja, it is actually turned back, at any rate on the surface, so much more powerful is the current of the latter river. The adjacent banks show the characteristic steppe and underwoods, and the country behind them is open. In two or three places we perceived fresh tiger-tracks. A little higher up, the river is crossed by the road from Chotan to Ak-su. This road, beginning in the district of Sil on the lower Chotan-darja, follows thence an old bed of this river, which is now completely dry and in part sanded up, passing on the way through dense, luxuriant toghrak woods, which are visible from the lower course of the Jarkent-darja, though they do not reach all the way to it. After crossing over to the other side the road continues up the right bank of the Ak-su-darja to Avat. This town, which is stated to consist of 1024 families under the rule of a bek, contains a bazar. Its irrigation interests are looked after by a *mirab*, or »water superintendent».

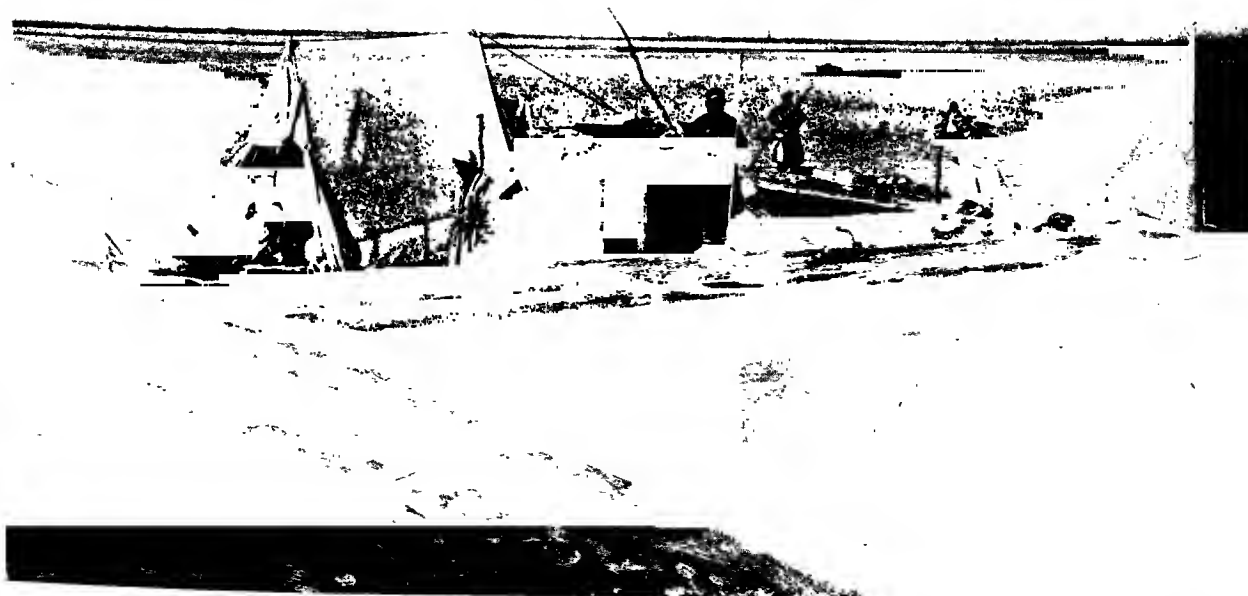
Here it may be convenient to add a few further particulars which I gleaned from two or three natives of the locality. It was expected, that the Jarkent-darja would freeze in about 45 days, that is to say, about the 11th December, and the Ak-su-darja about the 21st of the same month. There is always a difference of about ten days between them in this respect, because of the greater velocity of the Ak-su-darja. The ice does not however remain, at the most, longer than three months. In the summer the water of the Ak-su-darja is always colder than that of the Jarkent-darja, though in the late autumn the difference disappears. The maximum summer flood of the Ak-su-darja reaches the confluence two weeks earlier than the summer flood of the Jarkent-darja. The water of the former stream is always turbid, and carries in suspension a large amount of sedimentary matter; whereas the latter, by reason of its more sluggish flow and its smaller volume, occasioning in consequence less extensive erosion of the containing banks, always has the clearer water. The chief topographical names on the left bank of the lower Ak-su-darja are as follows: — Ak-tschakil, Jäti-germe, Sugetlik, Kalaghatsch-jalangi, Masardung, Goro-tschöl-kemisi, Taghar-aghisi, Imam Padischahim-kemisi, Dung-kischlak, Kara-tal; and on the right bank: Aral, Schupurluk, Gais Bek-temi, and Imam Bet Ali Ghasim-masar. In each case the enumeration proceeds up-stream. The two places whose names end in the suffix *kemisi* (»ferry») are crossing places. Higher up, nearer Ak-su, the current is too swift to admit of the use of ferry-boats.

When the Ak-su-darja flood arrives, it advances up the Jarkent-darja as high as Jesi-köl, and no doubt occasions a perceptible »bore» or flood-wave a considerable distance higher up than that; and considering the steeper fall in the bed of the Ak-su-darja and the extremely gentle fall of the Jarkent-darja, it may be assumed, that this flood-wave has not entirely spent itself when it encounters the descending high flood of the latter stream.

As I have already said, the bed of the Ak-su-darja at the confluence is of immense width, so wide in fact that the woods on its left bank appear in the distance like a dark line merely. At their foot however lie, stretching a long way out towards the middle of the river, vast alluvial formations in the shape of immense deposits of silt and sand, of a light grey tint. These are traversed by a side-arm of the river, the main current flowing close in to the right bank. On the



RIGHT BANK OF THE JARKENT-DARJA AT THE ACTUAL CONFLUENCE OF THE AKSU-DARJA.



*Ljustr A. B. Lagrelus & Westphal.*

JARKENT-DARJANING-KUJLUSCHI. VIEW LOOKING N.E. FROM THE CAMP.

To the Right is the Peninsula between the Jarkent-darja and the Ak-su-darja.



left of the actual confluence, close beside the spot where we were encamped, there is a reach of »dead» or stagnant water. On that side, wherever the sedimentary deposits will allow of it, the vegetation comes down to the margin of the water. Along the actual line of first contact of the two rivers, and a short distance from the bank, there is an eddy with a »dead» centre, where a mud-bank has formed. It was close beside this spot that we obtained the maximum depths, namely 2.95 m. and 3.92 m. At 1 p. m. on 28th Oct. the water of the Jarkent-darja had a temperature of  $8^{\circ}.40$  C., while its transparency was 21.6 cm. The corresponding data for the Ak-su-darja were  $8^{\circ}.35$  C. and 13.8 cm. respectively. Thus, autumn though it was, the water of the Jarkent-darja was a good deal clearer, as well as a shade warmer, than the water of its sister stream.

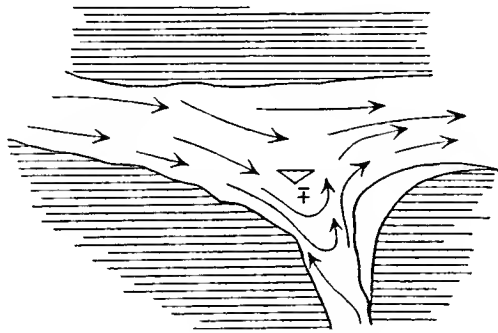


Fig. 80. THE REACH OF DEAD WATER AT THE CONFLUENCE OF JARKENT-DARJA AND AK-SU-DARJA.

## CHAPTER VI.

FROM THE CONFLUENCE OF THE AK-SU-DARJA  
TO INTSCHKÄ.

October 29th. During 35 hours the level rose another 2 cm. Twelve or fifteen days later, when the overflow from the irrigation channels should have reached the river, it was expected that it would begin to rise at a more rapid rate. At 7 a. m. the transparency was 12.2 cm., and at 1 p. m. 14.6 cm. The arm which cuts its way through the vast alluvial deposits has a double mouth, the two embouchures being parted by an island. After the narrow and relatively insignificant Jarkent-darja, the united stream makes quite an imposing flood. The woods are far off; the banks nearest to the river clothed with steppe and scrub. Generally speaking, only about one-quarter of the river-bed is occupied by the current. During the day the stream described one huge bend, and a couple of minor sinuosities. The velocity was rather unequal, very swift at first, though afterwards it diminished a little. Between it and the sluggish flow of the Jarkent-darja there was a very striking difference. Although the containing banks were, as a rule, not more than 1 m. high, they rose occasionally to as much as 3 m. The summer flood had been 1.3 m. above the level of that date (29th Oct.). The depth was even less than in the Jarkent-darja, and owing to the muddiness of the water our ferry-boat frequently ran aground upon the mud-banks. The first clump of poplars we came to on the left bank was called Top-toghrak, the current sweeping in close under its foot. Here, at Chotan-kemisi, the river is crossed by the trade-route between Chotan and Ak-su, that is to say, by the right branch of it, which then proceeds up the right bank of the Ak-su-darja to Matan. Meanwhile the left-hand branch, after crossing the Jarkent-darja, ascends the left bank of the Ak-su-darja to Avat. The former is the road habitually taken by the caravans, the ferry-boat at Chotan-kemisi (the Chotan Ferry) being big enough to transport six camels across at once. Formerly the big river was joined at this place by a branch of the Chotan-darja, a branch which as late as the time of Jakub Bek, or in the seventies, still carried a little water, though it is now dry and sanded up. The natives are of opinion, that this branch was once the main stream of the Chotan-darja, and that, like all the rivers of East Turkestan, it has since shifted its course to the right. In 1895 my route lay along a portion of this dry branch.

The riparian tracts on the right of the big loop I have mentioned are called Schor-kasch and Kara-ködschäk. Then follow, on the left bank, the village of Schejklerning-tamlari, with ten families, several heads of which are »sheiks» attached to the masar of Sultan Ali Katta Busrugvar, which, with its *chaneka*, its *gumbes*, and its streamers and poles, stands a good bit back from the river. At Kara-tal, a day's journey north of the river, agriculture is carried on; as it also was until recently at Schejklerning-tamlari (the Sheiks' Huts), the fields here having been destroyed by an inundation. The little dwellings are pleasantly embowered in a grove of *täräk* and *toghrak*, and the people possess a canoe, with which they maintain communication with the opposite bank. On the left bank, in a district called Kujlusch (the Confluence), the Tarim is joined by two small tributaries, or rather by one tributary with two mouths, one of which contains a lagoon. The water which this affluent brings is *bulak-su*, or »spring water», coming from the canals of Arka-jilgha and Kara-tal. On the right bank we next note Intschkä-dige-tam, with one family, and a little way from the bank Chalpa, with five shepherd families. Then comes, on the right bank, Tolan-kemisi, taking its name from a well-made boat, with oars, which belongs to the bajs of Kara-tal, who pasture their sheep on Aral, the triangular tract of land bounded by the Ak-su-darja, the Chotan-darja, and the dry branch of the last-named. The word *aral* means »island», and the name still survives, although the tract is no longer an island, but only a peninsula, in consequence of the branch of the Chotan-darja having dried up. On the left we then have the village of Schor-tschokti, inhabited by four »schejk» families.

From our camp on Aral it was stated to be a three days' ride to the great highway between Ak-su and Kutschar. Twenty potaj, or 72 km., south of that highway there is said to be a river-bed called Atschik-jilgha, fed by natural springs lying east and south-east of Ak-su; this, in summer, when it is full, returns to the Tarim through the district of Choras-öldi. Except for a few pools, it was, however, at this time quite empty and dry. Between the Atschik-jilgha and the Tarim stretches a belt of drift-sand, the Kisil-kum, interrupted at intervals by forest, steppe, or naked mother earth. During the course of the day we passed six *tor*, or trumpet-shaped baskets, for catching fish. They were fastened to stakes fixed in the bottom of the river, as well as to poles thrust horizontally into the bank, and the fish were guided into them by means of a palisade built in the river and converging upon the mouth of the trap.

October 30th. A rise of 0.9 cm. Transparency, 13.2 cm. The summer flood had risen 2.37 m. above the existing level. The river's windings were now of great length and their angles obtuse; in fact, we did not double a single rectangular loop throughout the day. Thus the waterway was very little longer than the path from Chotan-kemisi to Schah-jar, which accompanies the river on its left bank. At Egri-jar, the first of the north-going loops which is touched by this path, the bank is very distinctly marked, although planted with tamarisks, and behind it we caught distinct glimpses of the Kisil-kum sand-belt. Then, after passing Jildis-toghrak, where there is a homestead amid a grove of poplars, we came to the second loop, called Kara-dung, on whose sandy soil tamarisks were again growing. The region on the opposite, or right, bank is known as Kasan-asma. Some of the so-called houses



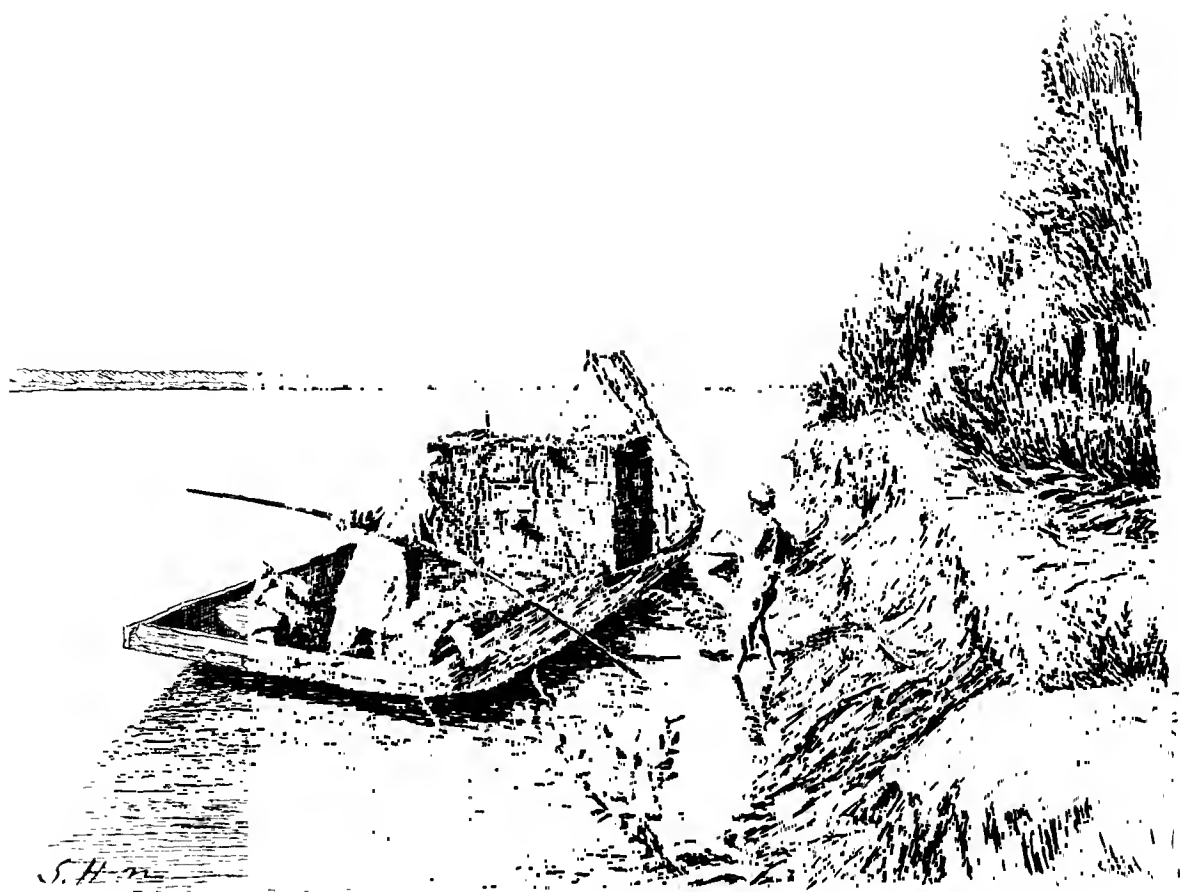


Fig. 81. THE TARIM BELOW THE CONFLUENCE OF AK-SU-DARJA AND JARKENT-DARJA.

hereabouts are in reality earth-caves (*germe*) excavated in the ground. A little below Busuk, on the left bank, there is a masar, Ak-tschol Busrugvar. In this locality the Chotan-darja sends off an arm at high flood to feed the small circular lake of Hamdan-köl. The tract on the left bank of the Tarim immediately opposite to the north-east corner of Aral is called Tavak-kaldi; while the right-hand angle between the Chotan-darja and the Tarim is known as Kan-begi. During the second half of the day's drift the river was extraordinarily straight, the sharp bends and semicircular windings of the Jarkent-darja being now replaced by long, gentle curves. True, the current meanders from side to side of the expansive river-bed; but its curves are seldom sharp. Viewed from a spot near the embouchure of the Chotan-darja, the Tarim flows on and on to the east until in the extreme distance it becomes lost as it were in a vast ocean. Scrubby woods and kamisch steppe are generally prevalent; full-grown poplars occur in thin and widely separated clumps. Still, there is some forest, although it stands well back from the river.

The Chotan-darja, at the spot where it joins the Tarim, makes a broad open passage-way through the scrubby forest, and the river apparently presented the same characteristics which I observed when I traversed its lower course in 1895. That is to say, its bed was broad and level, bare and dry, and its margins overgrown with reeds, underwoods, and solitary, but well grown, poplars. I say

its margins, for banks strictly speaking it had none, or at best they were very faintly indicated. The stream, when there is one, would appear to fill the bed pretty evenly from bank to bank. The bed itself is a couple of meters higher than the level of the Tarim, and shelves down to it right in the mouth of the river. Indeed the natives assert that the Chotan-darja does pour its flood with unexampled violence into the Tarim, which has generally at that time begun to drop. But however great or powerful the contribution of the Chotan-darja, it has apparently no effect whatever upon the main stream, which never deviates in the smallest degree from its settled easterly direction. At the same time the united stream after the confluence is a good deal broader than the single stream above it. Here too steppe and scrub withdraw to a wide distance apart, and the river contains extensive deposits of alluvium. This is unquestionably due to the vast masses of material which the Chotan-darja brings down from the loose ground it traverses in the course of its short existence. And the same story is told by a continuation of the Chotan-darja called Kara-kertschin, which branches off from the Tarim over on the left side of the latter. This stream, now dry and choked with vegetation, wheels round to the east-north-east so as to rejoin the Tarim at Atschik-darja. The space thus inclosed is likewise called Aral, or the Island. Thus the Tarim once flowed here for a considerable distance through two roughly parallel arms, and it is not unlikely that the Chotan-darja, being then of greater volume than it is now, in its efforts to preserve its natural south-north direction, as well as through the pressure of its flood, may have helped to form the bifurcation. When however the Chotan-darja began to dwindle, so too did the Kara-kertschin arm become less and less used. The Tarim was, it is true, still divided into two arms just above our camp at Kanbegi, though the intervening space consisted only of sedimentary deposits. Similar accidental bifurcations, depending upon the local alluvial formations, are quite common in this part of the river. As a rule, however, the current keeps to a single channel, and its cross-sections are fairly well represented in the subjoined cut made at Busuk.

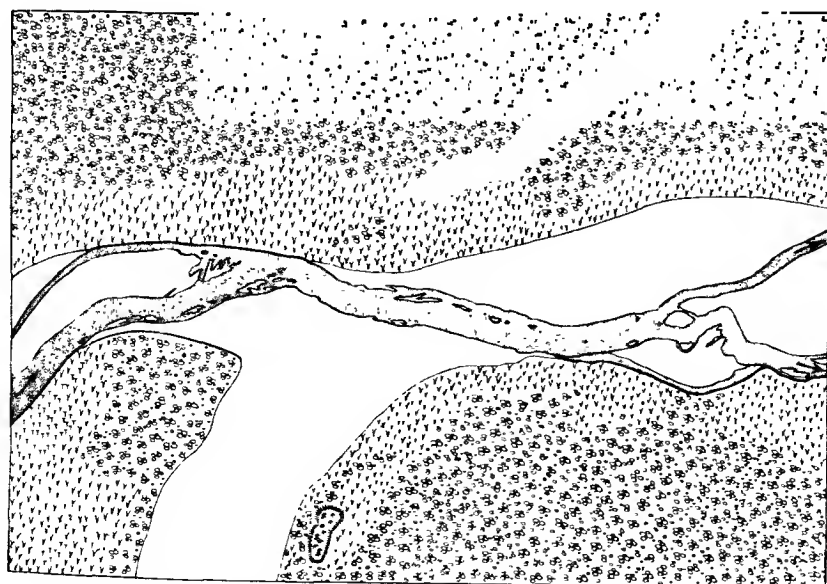


Fig. 82. CONFLUENCE OF CHOTAN-DARJA WITH THE AK-SU-DARJA.

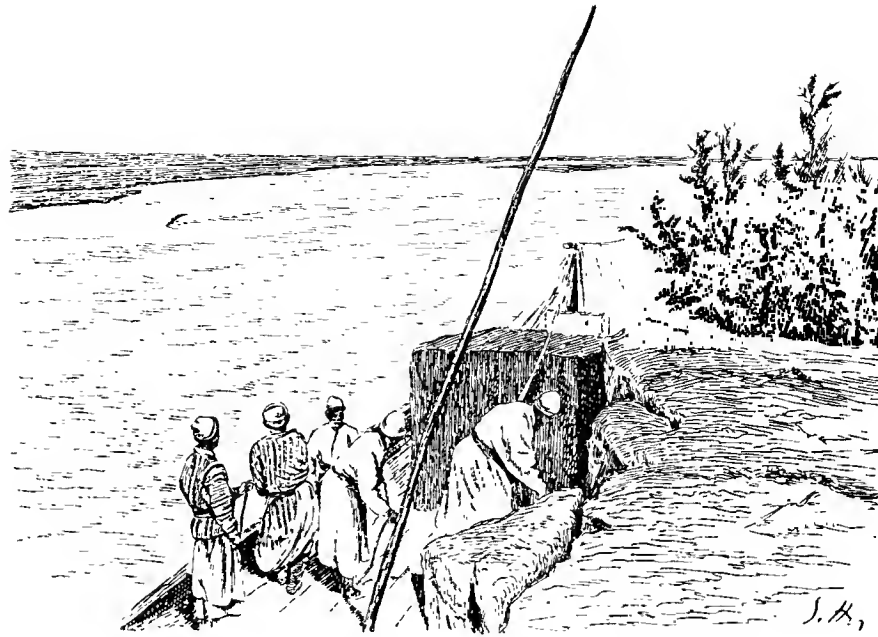
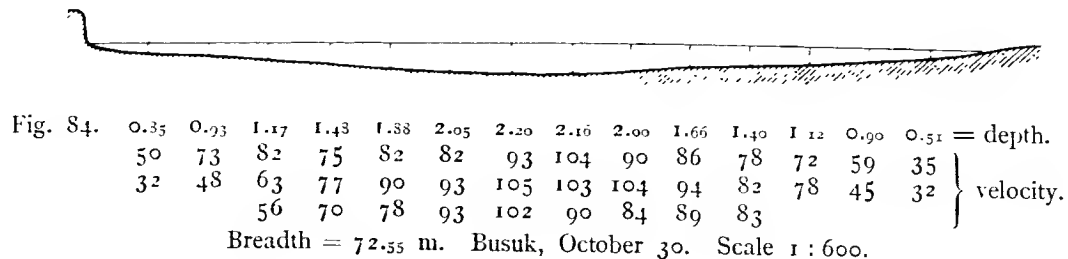


Fig. 83. TARIM BELOW THE CONFLUENCE WITH CHOTAN-DARJA.

According to what I was told by the natives of the locality, the Chotan-darja, after flowing all August and all September, had ceased to flow on the last day of the latter month. It first makes its appearance as a thin rivulet, but swells out to its maximum volume within a single week. The greater part of its water arrives during the last weeks of August; in September the volume which it contributes to the Tarim is altogether paltry as compared with what it brings down in the preceding month, and by the end of September it has dwindled to a tiny stream, which eventually fails altogether to reach the main river. Others of the natives affirmed that the Chotan-darja did not flow more than 40 days in all, but that its current is extremely violent, as well as heavily charged with sand and silt. So violent is it that upon bursting into the Tarim it thrusts the latter aside, forcing it close up against the opposite bank. The length of time during which it flows is no doubt dependent upon the amount of precipitation on the northern border-ranges of Tibet, and consequently varies from year to year. The difference between a year with a heavy snowfall and a year with a light snowfall is transmitted with accentuated force to the mouth of the Chotan-darja.

The following would appear to be the chief climatic peculiarities of this particular region. Every summer there come five or six severe burans or sandstorms from the north, each accompanied with darkness, and often lasting for the full space



of three days. The tempests which come from the south are far less frequent, and much less violent. Such rain as there is, and it is quite insignificant, occurs in summer. The fall of snow is slight and varying: for instance, in 1898 there was no snow at all, whereas in the year preceding there was a fairly large quantity.

At Busuk we obtained the following measurements: breadth, 72.55 m.; mean depth, 1.354 m.; mean velocity, 0.7547 m.; and volume, 74.13 cub. m. in the second. On the last occasion that we measured it, the Jarkent-darja carried a volume of 14.96 cub. m., or only one-fifth of the volume at Busuk.

October 31st. Rise, 0.9 cm. in twelve hours. Thus the river continues to rise, as we were told it would. The transparency at 7 a. m. was 10.9 cm. and at 1 p. m. 11.5 cm. At our camp the containing banks were 1.88 m. high, and the high-water level 1.48 m. above the existing level of the stream. At Busuk the containing banks were 2.75 m. high; though the altitude naturally varies with the inequalities of the ground, here, however, slight, and the high-water level is of course to a certain extent governed by the breadth of the river-bed.

When, as happened to-day, the wind blows strongly (from the east), the broad bosom of the river is crumpled into waves, their crests tipped with foam. These of course assist to erode the banks; or rather the beat of the waves exercises an abrasive effect, which soon becomes obliterated in the work of erosion that is continually going on. The broad, open face of the river lies fully exposed to the wind, for the woods on its banks are too far apart to offer any impediment to it.

On the right we passed the masar of Uj-baschi Busrugvar, and further on a small toghrak grove called Modsche-toghrak. Generally speaking, the banks are covered with thick beds of tall reeds, with tamarisk thickets dotting them like islands. The sandy belt of Kisil-kum is said to lie 18 km. to the north, and the big sandy desert of Takla-makan twice that distance to the south. At our camp the containing bank was 3.1 m. high, and the high-water level lay 1.96 m. above the existing level.

November 1st. Rise, 0.5 cm. Transparency, at 7 a. m. 12.9 cm. and at 1 p. m. 10.3 cm. The two arms into which the Tarim divides immediately below the confluence of the Chotan-darja flowed together again a short distance below our camp; the western branch carried the larger volume. At Koghunluk, or rather Koghunlukning-toghraghi, there grew, a little way back from the right bank, a magnificent poplar wood. In this locality the current was very broad, filling more than half the river-bed, though this was indeed a good deal narrower than it had been hitherto. At Kaghdan the stream was shallow, and expanded into a small lake. At Tolan-kemisi, the second place bearing this name, there was also a small ferry-boat, which



Fig. 85. FERRY-BOAT OF TOLAN-KEMISI.

just at the time we passed was engaged in transporting across the river two or three shepherds and some sheep, and a baj with a couple of horses. These bajs own some 10,000 sheep, then grazing on the right bank; and the ferry-boat, which belongs to them, and is constructed of toghrak planks, and worked by a punting oar at the stern, is used to carry the sheep backwards and forwards.

Just below this point a very large river-bed, known as the Lajlik-darja, is shed off to the right. So far as is known, it does not rejoin the main stream. The small dribble of water which, at the season of high flood, finds its way into this deserted branch, is what is called *taschkan-su*, or »water flung away». I think it, however, not only possible, but probable, that the Lajlik-darja is identical with the Atschik-darja, the bed of which I crossed in 1896 whilst on my way from the Kerija-darja to Schah-jar.

After that the right bank is called Tumurluk, and the left bank Uruk-bälik, whence it is 11 km. to the sand-belt of Kisil-kum. On both banks there are shepherds. Then follow Boghu-baschi on the right, and Kara-toghrak on the left. At Kara-toghrakning-kemisi there is another ferry, with a ferry-boat of the same type as the last I mentioned, 9 m. long, 1.2 m. broad in the forepart and 3 m. in the stern, and capable of carrying over five horses at once. Hereabouts the river was very narrow, and the current so swift that in two or three places it actually broke into rapids. Next on the right we had the steppe of Ak-jar, with a belt of forest, Manan-kotan, standing a little way back from the river. Thence it is about 35 km. to the great sandy desert. The left bank is bordered by a belt of sand, the Ala-kum, which in all probability is somehow connected with the Kisil-kum, and between it and the river lies a tract of country covered with tamarisks, and known as Jol-aghsi, »the Mouth of the Road», indicating that a road here strikes the Tarim. The river then describes a long arc of wide radius until it comes to Läschlik, where it suddenly turns at a right angle. In this locality there are alluvial deposits of vast extent under the left bank.

During the day the course of the river had been towards the north-north-east. The banks were clothed with fields of yellowing kamisch. The soil was saliferous, and white on the surface. Tamarisks were especially numerous. In the immediate vicinity of the river the poplars occurred in small clumps only; the continuous forest still stood a certain distance back from it, and seldom approached it — in sharp contrast to the forests beside the Jarkent-darja. Although the season was so far advanced, the banks still continued to suffer severely from the erosive energy of the current. This is especially the case where they are of a sandy nature, or where the sand-dunes actually reach down to the brink of the stream. In these places they are being incessantly undermined, and we not only saw them, we also heard them, caving in and being carried away wholesale. At times, just whenever the falling earth came into contact with the water, the margin of the river actually appeared to smoke. Where clay formations, or formations of clay mingled with sand, are predominant, the banks do not crumble, they break down in big slices.

November 2nd. During the night the river dropped 3.43 cm.; the transparency was 13.5 cm. at 7 a. m. and 7.6 cm. at 1 p. m., this latter measurement being taken in the Jangi-darja, which was choked with sedimentary matter. At Läschlik



*Ljustr. A. B. Lagrelus & Westphal*

OUR CAMP AT ALA KUNGLEK BUSRUGVAR. VIEW LOOKING W.S.W



the eroded banks were 2.50 m. high, and the high-water level was 2.01 m. above the actually existing level. The humid parts of the banks were now frozen every night and quite hard in the morning. Just below Läschlik we turned the sharpest angle we had yet encountered in the Tarim. Here the river has accumulated vast quantities of sedimentary matter, and the only vegetation on its banks are tamarisks. It is at the north-west corner of this angle that the river is again joined by the Kara-kertschin, and immediately below the junction begins the old channel of the Atschik-darja. This is another Atschik-darja, and is not to be confounded with the bed of the same name on the south side of the Tarim. Although both channels were now in part thickly smothered in vegetation, they were both distinctly perceptible as well-marked depressions running through the tamarisk-clad hills. A short distance below the mouth of the northern Atschik-darja a deep and well-made irrigation canal is cut through the containing bank, and leads to the Atschik-darja, with which it then coincides as far as Juldus-bagh, a place situated a day's journey from Kutschar. There was about 0.5 cub. m. of water in the canal at the time we passed it. At Gurkur, the banks were outlined with extraordinary sharpness, and continued to be so for the rest of the day. The soil was growing more sandy as we advanced. In the still, keen morning air, when sounds travel a long way across the water, the falling masses of sand kept up, as it were, an almost unbroken roar as they toppled in all along the high banks. Thus the stream was actively at work; hence it is easy to understand how its bed must alter from year to year. In this part of its course the river is unusually full of sedimentary deposits, more than half of the area being alluvium. The bank opposite to Gurkur, where the river describes a sharp bend, is called Schor-köl. The velocity

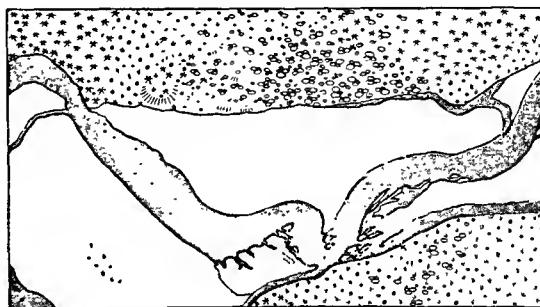


Fig. 86. THE BEND AT GURKUR.

too was increasing; at Mätschit-dung it was 1.3 m. in the second. In places the surface was broken and frothed, pointing to the presence of shallows and traverse bars or ridges on the bottom. A distinctly marked line along the faces of the banks showed how much the river had dropped during the night. The locality to the south-east of Mätschit-dung is called Schambuluk. At Topa-kaschte, on the left, opposite to the poplar grove of Ghas-atti, we observed the beginning of an old abandoned loop, quite dry except for a single pool known as Karaune-köl. A little way back from the same bank stands a *bostan*, or »clump of poplars», with a house, called Ak-dung; and just above another clump of the same kind of tree, on the same left bank, at Balik-öldi, the river bifurcates in a remarkable way. The arm on the left, a kona-darja, or »old river-bed», which re-enters the Tarim a day's journey lower down, used until 1895 or 1896 to carry the main volume of the river; though some little time previous to the last-mentioned year another, newer arm had begun to form on the right. This gradually widened and deepened, until in 1896 the current deserted the Kona-darja, and poured itself through the new arm. After that the Kona-darja dried up, except for an occasional pool



still left in its deepest parts. The forest, however, and the luxuriant belt of vegetation still remain beside the Kona-darja; though the shepherds who graze their sheep there have no water except what is in the pools in the river-bottom and the wells which they likewise dig there. The new channel, the Jangi-darja, runs through a bare sandy region, with scanty grass, dwarf tamarisks, and solitary poplars. In other words, when compared with the fresh vegetation of the country we had hitherto travelled through, the tract we now entered upon is desolate and like a desert. But, since the stream itself pursues a changeable course, the belt of vegetation has no alternative but to follow its example. In fact, it almost results as an axiom, that the more changeable the river and the oftener it alters its course, the broader grows the zone of vegetation which accompanies it. In 1896 I found it, between the Atschik-darja and Schah-jar, fully a three days' journey wide. Wherever the river shifts its course for a longer distance, as it did here, the area of country which comes within the radius of its life-giving waters naturally increases, and ere long fresh vegetation and fresh woods begin to grow up beside the new stream; while the zone of vegetation beside the old channel still remains alive, indeed in some places, as here, even shows, after some time, no indication of dying away. But then there are other factors come into play, such as the ground water, the nature of the soil, the distance between the old river-bed and the new, and so forth. Lower down we shall come across other localities in which the forest left beside an abandoned arm is in process of dying, and others in which it has completely died. The scanty vegetation which we found beside this Jangi-darja had not of course sprung up subsequent to the formation of the new bed, for this is not more than three or four years old, but it already existed before that event, the roots having of course only a relatively short distance to go to reach the natural supplies of ground-water. But if the stream remains constant to its new channel, the forest will eventually spread, as well as the trees grow in size and vigour.

The new bed of the Tarim is very much narrower than the river above the bifurcation. Seldom indeed does the breadth anywhere reach 100 m.; but here it contracts in one place to barely 20 m. The eroded banks were marked with the utmost distinctness, some being vertical, others very steeply sloped, and others, where the tree-roots and the roots of the kamisch still held, even overhanging. Every now and again, however, these give way, and a big slice of the bank plunges bodily into the current, setting an immense litter of kamisch roots afloat on its agitated surface. Indeed, the quantity of drift-wood and broken branches on the Jangi-darja is especially great, to say nothing of the tree-trunks, and even kamisch stalks, which stick fast in the bottom. In a word, the surface of the Jangi-darja was covered with rubbish, and its water thick and muddy. And it is obviously the same in every freshly-formed channel, for everything that happens to



Fig. 87. SECTIONAL OUTLINE OF THE JANGI-DARJA.

be growing in the path of the new stream is sooner or later rooted up and swept along with the advancing water, which thus becomes thick and turbid. Nor does it clear until the river settles with some degree of permanency into its new quarters.

Not only the appearance of the Jangi-darja, but its whole conformation, go to show that it is of recent origin. No doubt the reason why the stream seeks a new path is that the old channel has become choked with sedimentary matter, and its bed being thus raised, it is forced to seek a lower level. At any rate, the velocity in the new bed was greater and the fall more appreciable. But these characteristics will tend to disappear in the course of time, when the erosive energy of the river has been sufficiently long in operation. At first the Jangi-darja is perfectly straight and the actual channel follows the shortest line, so that the stream is swifter than a river which is full of windings. The velocities we measured were 1.68 m. and 2.05 m. in the second, the latter being the maximum; and at the season of high flood it is no doubt greater still. In such a deep, narrow channel the swift current makes of course greater work with the banks. Even now there are, in fact, appreciable deposits of alluvium, though they are nothing like so extensive, of course, as those which lie in the Tarim above the point of bifurcation. The destructive power of the current was especially manifest at the bases of the containing banks, which as they become undermined, fall over into the water, very often with a deafening splash. In this way the channel grows gradually wider, and begins to wind; and then, in proportion as the windings become lengthened out, the velocity tends to diminish. Thus, notwithstanding that the Tarim is a very ancient river, it is possible to study it in some places as though it were a stream of quite recent origin; in fact, passing down it as we did, we had opportunities of studying it at almost all stages of development. In some localities it is so ancient, and so well settled, that it seems as if it had flowed in one and the same bed from time immemorial; whereas in other localities it is extremely capricious and undecided. As a rule, the latter character becomes more and more pronounced the further the river advances from its source. Above Jarkent, owing to the configuration of the ground, it is not possible for it to quit its bed; but downwards from Lajlik, where it enters the low, flat plains, there is no longer anything to prevent it from deviating to right or to left as it finds occasion. And by the time it has travelled to the Lop country, through a region which is almost a dead level, its instability and readiness to change have attained their maximum, and the river becomes subject to alterations of the greatest magnitude.

The Kona-darja keeps pretty near to the new channel which has supplanted it. About 18 km. beyond it lies the Atschik-darja, and beyond it again, still farther to the north, extends the narrow sandy desert of Kisil-kum, though it comes to an end a considerable way short of the Ak-su-Kutschar road. In this part of the country it was estimated that there were 30 shepherds living, and that they had charge of some 10,000 sheep, belonging to merchants in Ak-su and Schah-jar. Ten of the shepherds dwelt in the Kona-darja. These men, unlike those higher up the river, and unlike the shepherds of the Chotan-darja, who lead solitary lives in the woods, had their families with them. Between the beginning of the Jangi-darja and Chotan-kemisi it was estimated that there were another 30 shepherds.

It is here about 40 km. southwards to the great sandy desert, but at half that distance lies the Lajlik-darjasi. This, like the southern Atschik-darja, is reported to carry a little water at the height of the summer, though in autumn and winter it all disappears, except for a few isolated pools. This information points to the two channels being distinct. But whilst travelling from the Kerija-darja to Schah-jar on my former journey I crossed first a river-bed called the Atschik-darja, and after that three minor watercourses. The hydrographic relations here are not clear, but in all probability there is only one principal arm, namely the Lajlik-darjasi, which sheds off the Atschik-darja, and then, subsequently, the minor channels which run north of it.

Above the bifurcation of the Tarim there is on the left bank a sand-dune, Kade-dung, with some poplars. After that we had, on the right bank, Koj-baschi, Sägislik, and Schaklik, and again on the left Matischim-dung and Bitschanlik. Schaklik stands on the boundary between the provinces of Ak-su and Schah-jar. At first sight, it may appear strange that the banks of a river only three or four years old should have attained to the dignity of distinctive names. Yet it is in reality not so very surprising after all; for some of these regions may have borne names already before the river's advent; besides this, there are various reasons which might dictate to the natives the expediency of giving names to these new tracts at an early date. The local nomenclature is determined sometimes by quite trivial occurrences, as Balik-öldi, or the Fish Died; sometimes by some outstanding feature of the locality, as Kade-dung, or the Pole Hill, and Sägislik, or the Clayey Ground; sometimes the old familiar names are transferred from the abandoned channel to corresponding tracts beside the new stream.

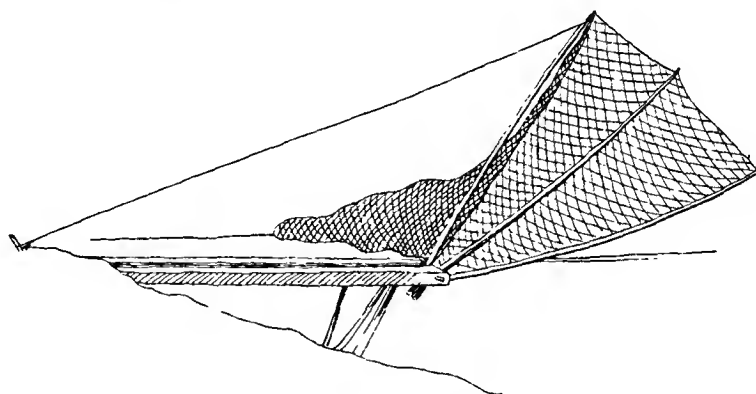


Fig. 88. A SOTOR.

In a toghrak wood on the right bank stands the masar of Ala Kunglek Busrugvar, with an oratory and a *kasan-chane*, or «kitchen», as well as the usual *tughs*, or poles with streamers, fixed in adjacent sand-hills. This spot is visited by pilgrims from Ak-su on the occasion of certain Mohammedan festivals. Here we found three shepherds, who expected that the river would freeze in 30 or 40 days, and declared that its level would be then 1 m. higher than it was at the time they spoke. In fact, the rise might begin at any moment. The ice attained a thickness of two feet, and as there was neither boat nor ford, this was the only means they had of get-

ting across the river. There exists not the slightest doubt, that the river does rise in the late autumn, though it may be open to question whether the rise is as much as a full meter. Probably this is in part caused by the freezing of the quiet reaches in the lower parts of the river's course, thus preventing the flow of the current.

From the masar of Ala Kunglek Busrugvar it is accounted a journey of five days to Schah-jar. Here the summer flood is unusually violent, and overflows the lower parts of the banks next the river. It is only very rarely that it rains in this region in the summer, and the snow-fall is both irregular and insignificant. The storms all come from the north and north-east, never from the east. Just below the masar we observed a peculiar *tor*, or »fishing apparatus», in use. It resembled a bat's wing in shape, that is to say, it consisted of three rods radiating from a common centre, and with a sack-like net attached. The apparatus is dropped into the water, and as soon as the fish are observed to be within the net, its mouth is closed by means of the rods, and the whole affair is then hauled in by a rope.

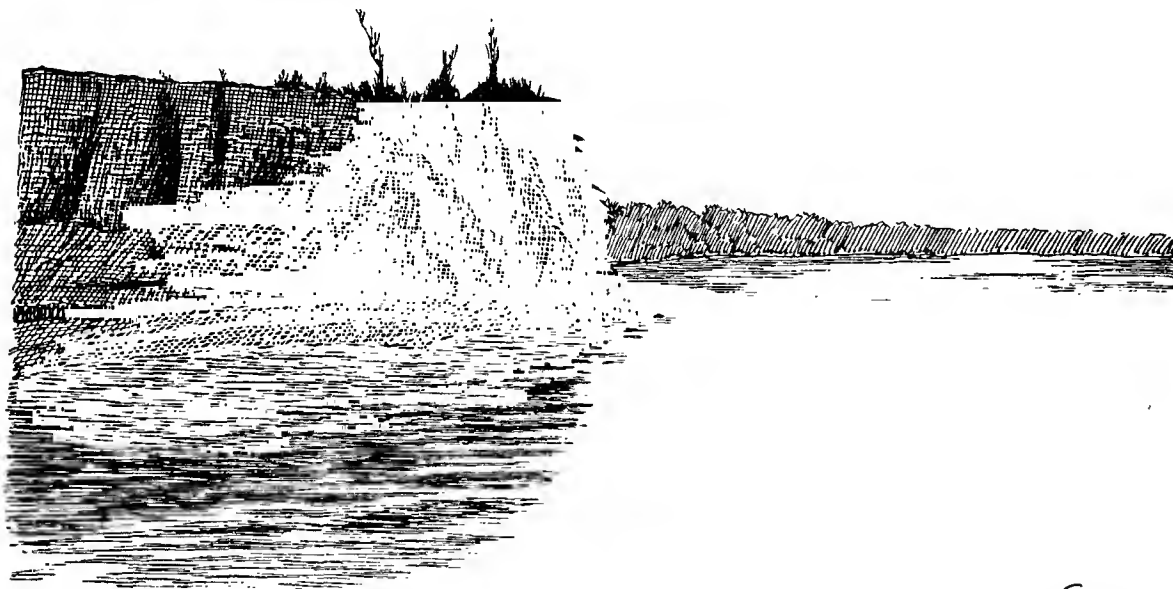


Fig. 89. ERODED BANK, RIGHT SIDE OF RIVER, 4.62 M. HIGH, AT ALA KUNGLEK BUSRUGVAR.

November 3rd. The rise amounted to 1.6 cm.; the transparency at 7 a. m. was 5.5 cm. and at 1 p. m. 4.2 cm. The water was like pea-soup, thick and muddy, and heavily charged with sand and silt. At the masar the containing bank was 4.62 m. high, and the high-water level was marked 1.51 m. above the then existing current. That is as much as to say, that the channel was more deeply and more sharply eroded than in the older parts of the river's course. The river is too new to have deposited sufficient sedimentary matter to have raised the bottom, the effect of which would be to make the banks relatively lower. The velocity in the lower part of the Jangi-darja amounted to 1.53 m. in the second, but at the mouth of the Kona-darja it was not more than 0.74 m., while farther down in the same branch it was even less. The diminution in the velocity of the lower Jangi-darja, as compared with its upper part, is due to its more sinuous character, its curves being some of them round, some acute-angled. The general direction is north-

east. From the second loop of the day's journey we came on the left to three small watercourses in narrow, but plainly marked channels, the third being especially sharp-cut, with steep faces on both sides. These watercourses, which come from the Kona-darja, and are known collectively as Kamar-darjasi, traverse a poplar wood. In what appeared to be an old abandoned loop of the Kona-darja we observed a desiccated lake called Ärmän-köl. This was on the left of the river; and north of it we found still in use the name of Julghun-köl or the Tamarisk Lake, attached to a dry hollow in what was said to be another loop of the old river. In 1898 a little water made its way down the Kona-darja at the time of the summer flood; but in 1899 the bed remained dry all summer, though the flood at its first appearance did indeed make an attempt to follow the old course. But the Kona-darja being now to all intents and purposes a *cul-de-sac*, the little water that enters it soon comes to a standstill, and remain stagnant.

Next we had, on the right bank, Porutschi-kotan; then, on the left, Tälpäk; and finally, on the right again, Ak-jantak-kum, a belt of sand which accompanies the river for some distance. Opposite to it is the lower extremity of the Kona-darja, making a broad gap through the woods. Again, we had on the right the district of Kartschigha-dschaji, and on the left Kantschik-öldi, where the river is split into two arms by a reed-grown island, with a high bank at its upper extremity and low alluvial deposits at its lower. The water in the left-hand arm was almost stationary. At Tälpäk, a second place bearing this name, we again made our camp beside the old Tarim. Here we found nine shepherds and their families, each in charge of 300 to 1500 sheep, the united flocks numbering altogether 8000 animals. In the tract of Ak-jantak there were 8 *aghils*, or »sheep-folds», with about 3000 sheep in each. The former group were within the administrative district of Schah-jar, the latter in that of Tschimen. In this locality the sheep industry stands at a relatively high level. Both the wool and the skins are bought by Andischan merchants living in Ak-su and sold to Russian Turkestan.

From these localities it is said to be a three days' journey south to the great sandy desert, where a few *pavans*, or »hunters», go to hunt the wild camel. The Arka-darja is reported to be only one day's journey in the same direction; consequently it flows considerably to the north of the desert, and very probably is identical with the Lajlik-darja and the Atschik-darja. A little water is said to trickle along the first-named in the latter part of the summer, but it becomes lost in the sand before it reaches the Tarim. This stream is totally unexplored, except that I crossed it at a single point in my former journey. The names given to it are significant. The Lajlik-darja means the Muddy River, a name pointing to the large quantities of alluvium which it contains. The Atschik-darja, the Bitter River, is derived either from the saliferous soil it flows through or from the pools which stagnate in its bed acquiring a saltish taste. The Arka-darja, or the Farther River, is so called because it lies beyond the Tarim.

Northwards it is three days' journey to the great Kutschar highway. Between it and the river stretches the Kisil-kum zone of sand, 5 to 6 km. wide.

The shepherds of Tälpäk had also made the observation, that the river rises before the ice begins to form. They considered that it had then reached its au-



*Lynstr. A. B. Lagretius & Westphal*

A STORA, A KIND OF FISHING-NET, AT ALA KUNGLEK BUSRUGVAR.



tumn minimum, and would slowly begin to rise. The ice first makes its appearance in the lower part of the river, and thence gradually advances upstream. It would begin to show in about a month; but during the first week it would thaw again every day, and thereafter would remain permanent for the winter. As soon as it breaks up in the spring, it gives rise to a spring-flood, and after this has passed, it is possible in many places thereabouts to ride across the Tarim.

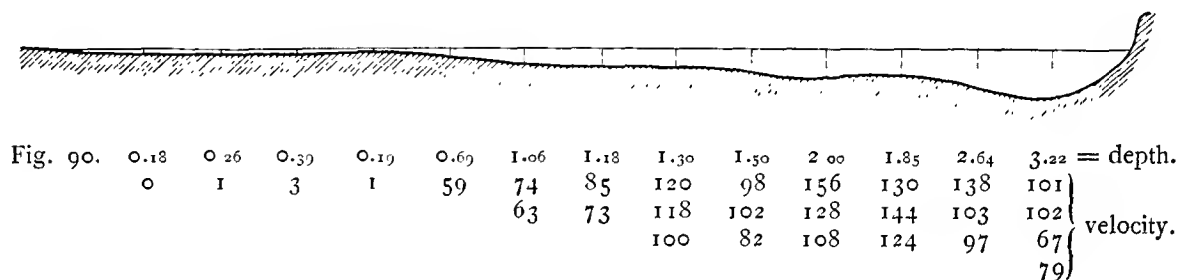
November 4th. The rise amounted to 4.8 cm. in 12 hours. The transparency reached 5.6 cm. at 7 a. m. and 5.9 at 1 p. m. The containing banks were 4.05 m. high, and the high-water mark was 3.21 m. above the existing level. During the first third of the day's journey, through the district known as Kumuteluk, the river presented its wonted appearance; but afterwards its aspect became totally changed. The most casual glance was enough to satisfy one, that it was no old channel we were drifting down: the bed was narrow and deep, and the current rapid, while the containing banks were steep and high, and totally destitute of poplar forests. Here the velocity was as much as 1.45 m. in the second. Kamisch steppe prevailed all day, interrupted at intervals by tamarisks growing on small sand-dunes, a sort of transition stage to the characteristic cone on which the tamarisk is usually wont to rear itself. The only poplars we saw, two or three in number, stood very wide apart, and were either stunted in growth or completely withered. After flowing for some distance perfectly straight, the river described three very similar curves, and thereupon several others of a more irregular character. In other words, the river was here something intermediate between a *kona-darja* and a *jangi-darja*; it was neither old, nor yet perfectly new. In fact, an older bed, called K  k-tschal-darjasi, which was deserted in 1891, breaks away from the left side of the Tarim immediately below Kumuteluk; but it rejoins the main stream a day's journey lower down. The tract between the two river-beds, designated K  k-tschal-arali, is overgrown with kamisch. Hence the present stream, to the south, is flowing through a new channel, beside which the woods have not yet been able to establish a footing. The only poplar wood we saw all day long was situated at the upper end of the K  k-tschal arm; but similar woods accompany the older bed throughout. During the last two summers no water had found its way into the K  k-tschal, though it had always previously done so; and except for a few isolated pools, it was quite dry.

Now it is a characteristic fact, that these old abandoned portions of the Tarim are almost invariably found to the north of the existing river; or in other words, the river tends persistently to shift its course to the right. The Arka-darja or Atschik-darja appears to be an outstanding exception to this rule; but then it is to be remembered, that we do not yet know whether this is an old river, or whether it is not possibly the first attempt at the formation of a new channel. The latter assumption is however unlikely, because the entire country intermediate between the Atschik-darja and the Tarim abounds in ancient forest. However that may be, the Tarim does undoubtedly manifest a decided tendency to flit to the right, a tendency which we shall find illustrated in a most convincing and irrefragable manner, when we get to the lower course of the river. If however the Atschik-darja really is a newly-formed arm, we may expect to find the entire river traversing it at no very distant date.



The right bank is known first as Teschme-kötäk, and then as Intschkä. The country which lies between these places and Tschimen was reported to be inhabited by 30 to 40 shepherds and their families. In fact, the region around Schah-jar and Tschimen is the most famous centre for the sheep industry throughout the whole of the Tarim basin, and without it the bazar of Schah-jar would be perfectly empty. It is 36 km. from Intschkä to the great desert, which is skirted immediately on the north by the Atschik-darja. Here tigers are occasionally seen. In this part the ice was expected to begin in about thirty days; and the river is said to freeze at Tschimen five days earlier than at Chotan-kemisi, and two days earlier than at Intschkä. The rate at which the ice-formation advances up-stream is stated to equal the rate at which the current flows down-stream, an assertion which certainly does not always hold good. The ice lies, it is said,  $\frac{2}{3}$  m. higher than the then existing level of the stream, and remains three months.

At Intschkä the breadth was 70 m., the mean depth 1.176 m., the mean velocity 0.8932 m., and the volume 73.51 cub. m., in the second, or very little less than on 30th October.



Breadth = 70.0 m. Intschkä, November 4. Scale 1 : 500.

## CHAPTER VII.

### FROM INTSCHKÄ TO KORAL-DUNG.

November 5th. A rise of 1.9 cm. Transparency 5.7 cm. at 7 a. m. and 4.6 cm. at 1 p. m. The banks were 5.12 m. high, and the high-water line stood at 2.72 m. above the existing level. At first the river flowed pretty straight towards the north-east, the only bends being at Egri-toghrak and Mal-pishti. It still continued to exhibit the same indications of being a relatively newly-formed channel — that is to say, it is narrow, rapid, and full of driftwood sticking up from the bottom, while on the banks are many tamarisk cones, partly undermined by the stream. The country is monotonous and desolate, yellow kamisch steppe being predominant, with tamarisks on their little mounds dotted about it like brown islands. The poplars are still few and scattered, though at the junction of the Kök-tschal-darja with the Tarim they flourish vigorously, as also all alongside the former stream. Below the junction the river resumes its usual appearance, and becomes both broader and slower. The woods were by this practically divested of all their foliage. After a good blow the river is often in great part covered with drifting leaves, especially in the eddies and backwaters, where they accumulate. During the day we passed several sheep-folds, e. g. at Häsemet-tokaj and Podung on the right bank, and again opposite to Opur, where there was a family in charge of 500 sheep. Here the river has yet another name, to wit Kobsak-darjasi, from the district of Kobsak on the left bank. At Bostan there were two shepherds' families. Of course it was only by pure chance that we saw any shepherds or flocks at all, for they generally keep of course to the woods and steppes, and only approach the actual margin of the river when they require to water their sheep, or when their folds happen to be situated on its banks. Hence it was impossible to form any estimate of the numbers of the shepherds on the basis of our own observations. Besides, these forest-dwellers are in many parts so extremely shy that they fled incontinently the moment they caught sight of our ferry-boat.

November 6th. The drop was 1.7 cm.; the transparency 5.6 cm. at 7 a. m. and 4.2 cm. at 1 p. m. The banks were 2.36 m. high, and the high-water level ran 1.98 m. above the existing level. At the first bend we found the shepherd homestead of Bostan. At Dästar a high-water branch breaks away from the river on the left, though

it very soon returns to it. A similar arm, which breaks through the opposite bank at Tschäläk, is considerably longer, and farther to the south-east lies the tract of Kongartschak-bel, and the woods in which I found shepherds after my journey up the bed of the Kerija-darja in 1896. At Tschege-jejnek there is an abandoned loop, three years old, and now dry; it lies north of the high-water arm recently mentioned. In the middle of it is an island, with a hut on it. It was surprising to find a human dwelling in such a situation, as there exists no visible means of communicating with the adjacent *terra firma*. I suppose the island was cut off from the bank by some caprice of the river. The strip of land between the main river and its right-hand branch is called Kum-aral, or Sand Island, pointing to the presence of sand-dunes. The latter channel re-enters the Tarim opposite an island, and just below a left-hand loop, the river there being fairly broad. Next came the locality of Dungkotan, where the river becomes in an especial manner complicated: it forms a complete figure 8, with a large island in the centre of the bigger loop, while the smaller loop is occupied by alluvial deposits. On the island there are some

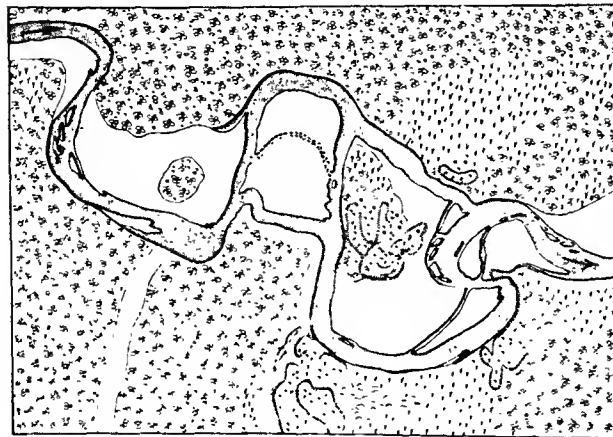


Fig. 91. THE DOUBLE LOOP OF DUNG-KOTAN.

unusually big sand-dunes bearing tamarisks, and themselves visible for a great distance both up and down the river. A very small artery leads off from the lower loop towards the right, and at full flood is entered by a minimum of water, which however speedily returns to the mother stream; when we passed, it contained only a tiny pool. Our camp at Kara-daschi was stated to be not very far from the channel in which we first discovered water after descending the Kerija-darja in 1896, though the said channel was now dry. The banks of the Tarim are here composed of sand-dunes, with poplars growing on them, but undermined to such an extent by the river that they form overhanging eaves and broken vaults, within which the roots of the poplars hang exposed. These are often as taut as ropes, proving that they too are anchored to the bottom of the river. The banks were in this place 3.46 m. high, and the high-water mark of the preceding summer stood at 2.36 m. In another two years these poplars will of course be completely undermined and swept away as drift-wood. Thus the river, by its transporting power, serves as an extremely successful agent for the dissemination of the forest. Not only does the water carry the seeds of vegetation to other tracts, but under favourable conditions young poplars and bushes, which get rooted up, are enabled to obtain root-hold again lower down in the spots where they happen to come to a standstill or are flung ashore. As the day wore on, the poplar woods once more showed signs of becoming more plentiful, though they were not indeed so thick as beside the Jarkent-darja. At Kara-daschi we found a canoe.

November 7th. In 14 hours the river rose 1.7 cm.; the transparency was 5.2 cm. at 7 a. m. and 4.0 cm. at 1 p. m. From Kara-daschi the river flows almost in

a straight line to the north-east, through the dense and magnificent forest of Hamdan-surasi. The local nomenclature in this part often applies to both banks alike. On the left we passed an island with poplars, with a pool of water on the other side of it, lying in a channel which only carries water at high flood. On the same side of the river are Kasch-kotan and Kasak-jajlaki, Kasak being a village a little north of the river. The shepherds of this place owned two canoes. These craft now began to approximate more to the Lop type, that is to say, they were long and slender, and easily managed. Bow and stern are, however, of a different shape; the former having a projecting nose, with a hole through it for a rope, while the latter is provided with a sort of platform to sit upon. The paddles resemble shovels, while the Lop paddles are flat and light. As a rule, the Lop-men's canoes are of a more finished make, as well as more skilfully adapted for the purposes for which they are used, the result of the experience of many generations. For those people however, the canoe is indispensable to existence; without it they could not fish; whereas it is nothing like so essential to the shepherds higher up, who only use it occasionally as a means of getting from one side of the river to the other. Canoes now began, as I have said, to be more numerous. At Tschong-aral we observed one, and at Peres, an important crossing-place, there were several.

At Tschong-aral, on the right, the river is joined by the old bed of the Atschik-darja, its mouth choked with mud and overgrown with vegetation. Down to this point the forests had been abundant; but they now receded from the river, until we were only able to distinguish them in the distance as detached clumps or long dark lines. At the same time the country again became open. We perceived, scattered over the now yellowing kamisch steppe the shepherds' huts (*satma*) and clay houses (*tam-uj*) standing at long distances apart. Here there is an old bank or terrace, at a very respectable distance back from the stream, its foot being reached by the water only at high flood. The exposed sedimentary deposits were frequently full of vertical cracks, the result of drying, possibly also of frost during the night. Where their sides had crumbled away, we were able to see the layers of varying thickness and consistency in which these sedimentary accumulations had been laid down. In the district of Gädschir our river was joined from the left by an arm of the Schah-jar-darja (Mus-art-darja), called Jilgha, the bed of which was filled with completely stationary water. This was blue and limpid, and the dividing line between it and the Tarim was most distinctly marked: the latter clouded the clear water of the Jilgha in flocculent wedges. In fact, the aqueous mass in the mouth of the latter acted like a continuation of the bank, against which the flood of the Tarim brushed in passing. The difference in their transparencies was very striking: whereas in the

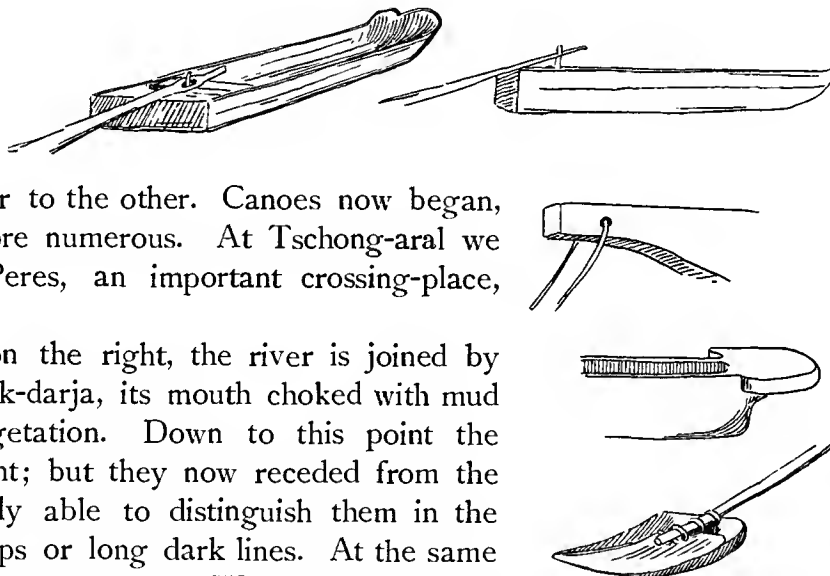


Fig. 92. TYPE OF CANOES  
ABOUT KASAK-JAJLAKI.

Tarim it was only 4 cm., in the Jilgha it was 78 cm. The velocity of the former was here 0.864 m. in the second. The breadth of the latter, just where it struck the Tarim, was 29 m., and its depth 3.34 m. The name Jilgha, or Valley, indicates that the bed of the watercourse is deeply trenched through the kamisch steppe.

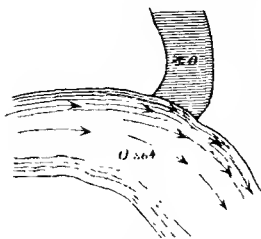


Fig. 93. MOUTH OF THE JILGHA IN THE TARIM.

Its margins were  $1\frac{1}{2}$  m. in vertical face, and were covered with reeds to the very edge, so that the channel resembled an artificially made canal. In the summer I was told that it carries a large volume of water, and the level was easily perceptible 1 m. above the existing level. It contained no alluvium above the water-level, but was of uniform width, and perfectly straight for as far as we were able to see. Owing to its water being stationary, it is said to freeze from 10 to 15 days sooner than the main stream. This arm, the Jilgha, breaks off from the Schah-jar-darja at Kum-arik, a day's journey from the Tarim. Two places, Kajlur on the left, and K  k-burun on the right, situated about 18 km. up its banks, are supplied by it with irrigation water. Due north-west of its mouth stands the masar of Sultan Muhamed Attam Busrugvar, with its *gumbes*, amongst sand-dunes bearing tamarisks.

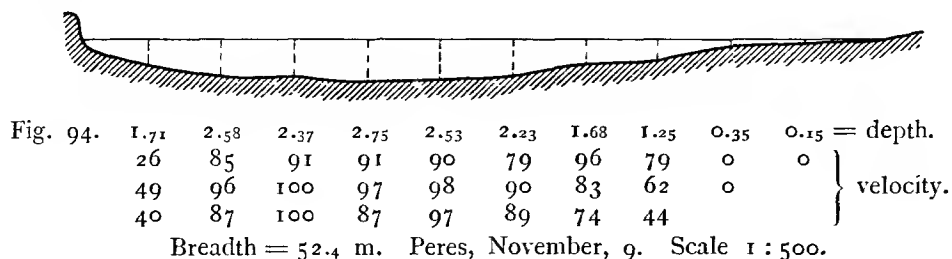
At Peres, immediately below the mouth of the Jilgha, the Tarim is crossed by the highway from Kara-dasch and Kongartschak-bel to Tschimen, Schah-jar, and Kutschar, — a route which I traversed in 1896.

Carey and Dalgleish travelled down the Tarim from the mouth of the Chotandarja in 1885. I myself journeyed down the river from Schah-jar to   rm  ng in 1896. It was, further, crossed by Prschevalskij at the confluence of the Chotandarja in 1885. And in 1889 Pjevtssoff advanced up the lower Kaschgar-darja and Jarkent-darja as far as Jarkent. Still these are not sufficient to give a correct idea of the river and of its characteristic features, for the routes that were followed led through the woods, and only touched the river's windings at intervals. As a rule, you do not see much of the river from those forest-tracks, it is obscured by the trees. And as I now mapped it from the ferry-boat between Peres and   rm  ng, it was perfectly plain to me, that the only way to obtain a true conception of its course is to travel by water, otherwise one runs the risk of mistaking a mere side-arm for the main channel.

Measuring the river at Peres on 9th November, we found the breadth to be 52.40 m.; the mean depth to be 1.600 m.; the mean velocity, 0.7550 m.; and the volume, 63.30 cub.m. in the second, showing a decided drop since the last measurement. Between 5 p. m. on 7th Nov. and 8 a. m. on 10th Nov. the level dropped 5.1 cm. On the 8th November the transparency was 5.4 and 2.3 cm. respectively, on the 9th Nov. 5.5 and 5.3 cm., and on the 10th Nov. 2.5 and 3.5 cm. at the two usual times of measurement.

I was unable to obtain any reliable information about the two large marshes Baba-k  l and Sarik-kamisch which figure on our maps, and consequently I am disposed to look upon them as myths, as having no actual existence. Of Baba-k  l the natives have never even heard; while Sarik-kamisch they know as the name of a marsh which dried up several years ago, and its site is now covered with kamisch and tamarisks, and an occasional sand-dune, and the soil impregnated with

salt. I dare say, that the streams which in this part of East Turkestan come down out of the Tien-schan form temporary isolated marshes, which become filled with water after copious rains, but are at other times dry. Still they are by no means so extensive as they are represented on our maps.



Below Peres the country still maintains its open character, the river is confined to a single distinct channel, and containing banks are almost entirely absent, or where present they do not exceed one meter in height. The current was swift, but the river-bed in general shallow, so that a relatively small rise quickly makes itself apparent. When I crossed the river on the ice at Peres (or Teres) in the winter of 1896, it had a breadth of 156 m., whereas now at precisely the same spot it was only 52.4 m. wide. Now it would of course be misleading to compare one year with another without taking other circumstances into consideration; for one thing, the precipitation is not the same every year. But the immense difference in the data quoted proves that the river actually does rise just before it begins to freeze, as the natives had all along asserted.



Fig. 95. CROSSING THE RIVER AT TSCHIMEN.

The banks still continued to be covered with kamisch and tamarisks, with an occasional poplar growing amongst them; and were dotted with numerous shepherds' huts and sheepfolds. But we only observed canoes at three places. The great forest was now a long way from the river, and only touched it at wide intervals with, as it were, an occasional projecting finger or promontory. The country on

the right was called Taraschah. On the left we had an isolated belt of barren sand, traversed by an old watercourse, which dried up long ago, and now joins the Tarim some distance lower down. The name given to it is Kuruk-darja, or the Dry River, a designation which is often employed for similar disused watercourses. Next we came, on the left, to Talluk-bulung, with two or three huts; then on the right, in a poplar grove, surrounded by sand-dunes bearing vegetation, to the masar of Sultan Kökmet Attam Busrugvar, round which the river describes a half-circle, in that, after flowing due east, it suddenly turns at right angles to the south. On the same side of the river is the Jeschil-köl, in a watercourse which only contains water at the season of high flood. Behind the opposite bank, which is overgrown with forest and kamisch, lies an unusually large and elongated lake, filled with gloriously translucent water. It sleeps in an arm which was then cut off from the Tarim, its mouth being completely dry, though it becomes filled at high flood. Immediately above this there is, also on the same side of the river, another watercourse, which, taking a short cut, rejoins the Tarim at Dästar near some huts and poplars. Below Bostan-toghrak there is another similar »short cut», with a miniature cascade in its lower part. The big south-west bend which the river makes here appears as if it were likely soon to be abandoned. The banks were again most distinctly scarped, and consisted mostly of sand and tamarisk mounds, more or less undermined. At Arik-aghsi we passed on the left yet another old watercourse.

November 11th. The drop in 12 hours = 1.3 cm. The transparency was 4.8 cm. at 7 a. m. and 4.0 cm. at 1 p. m. The banks were 2.05 m. high; the high-water level 1.77 m. In this part the river is known as the Ögen or the Terem, but is not called the Jarkent-darja. With the Intschkä-darja it stands in a sort of reciprocal relation, in that, when the Ögen is higher, a portion of its water flows over into the Intschkä, and when the latter is higher, a portion of its water seeks the Ögen. One channel, situated at Kök-tschol, serves both rivers. The course of the Intschkä, however, and the nature of its connection with the Schah-jar-darja have not yet been investigated. It is probable that the hydrography of the region is more intricate than our maps imply, and that one, if not more, of the streams from the Tien-schan find their way into the Tarim.

The banks of the river used now to freeze every night, though they invariably thawed again during the day. This caused them to crack, very materially assisting the erosive action of the river, as we could hear from the incessant landslips which kept occurring all through the warmer hours of the day. Indeed at noon we now began to see thin cakes of ice still remaining on the stagnant pools and detached sheets of water. Huts were very numerous, though it was only in two places that we found shepherds still living in them. We observed canoes at five places; they were now precisely of the same shape as the Lop canoes, though the paddles were still concave like shovels.

During the first half of the day's journey the river showed great fickleness, there being several abandoned loops on both sides, generally only one or two years old, and mostly quite short. Most of them, too, contained water, in every case frozen. The river is broad and shallow, and in several places overflows its banks at high

flood. These partake of the steppe character, with broken forest behind. The first abandoned loops that we passed on the left hand had been filled the year before by the high flood of summer. A big hut amongst the poplar woods on the same side was called Arik-aghsi-tallikning-satmasi. On the same side, again, we noted Lanka, and on the right Äschäk-tumschughi. As soon as we passed Bala-kojdi, the river became contracted into a more settled channel, the banks were again distinctly scarped, and big forests accompanied them on each side. The river-bed was narrower, and the alluvial deposits less extensive. The successive names by which the forest is distinguished are Schamal-kirtschin, Tüjang, and Tschingelik, with two or three clay houses. At Tugha-baschi three shepherds' families were living in clay huts, and each had charge of 300 sheep, belonging to merchants of Schah-jar, as indeed did all the sheep-breeding colonies along this part of the river. Between the locality last named and Jimbel-toghrak on the Schah-jar-darja, and 3 or 4 km. north of Tugha-baschi, stands the masar of Sultan Häkim Attam Busrugvar. The great desert was said to begin two days' journey to the south of the river. In the same quarter the natives report there are three distinct watercourses; the one farthest to the south, close to the margin of the desert, being the Atschik-darja; then, a day's journey from the Tarim, the Arka-darja; and, finally, quite close to the same stream, a Kuruk-darja. With regard to the two first named, they have been dry since 1882, except that a little water reached them in 1897, and is stated to be still remaining in a few pools; it is however salt and not fit to drink. All three are said to have their courses almost entirely through the sand; although north of the Atschik-darja there occur stretches of forest. The existence of all these watercourses, new and old, suggests that the Tarim system is here like a deltaic river, and quite as subject to change.

November 12th. In 13 hours a drop of 0.7 cm. Transparency, 4.4 cm. at 7 a. m. and 5.0 cm. at 1 p. m. The height of the banks was 3.87 m.; and the high-water line, 2.65 m. Here the river is extremely sinuous, narrow, and deep, so that our 6 m. punting-poles often failed to reach the bottom. The river-bed is old. The banks are high and sharply cut through the clay soil, and frequently coated with a thin layer of salt. The predominant vegetation is poplar forest, occasionally diversified with kamisch steppe; tamarisks are rarer. On the right bank we had Kum-kotan and Jughan-balik, with old and stagnant lagoons on both sides of the river. Then came Japma-notscha, Paman, Kemi-tschanti, Schor-tegischi, Sor-sure, and At-baschi, the only place during the day where we found shepherds dwelling. The latter part of the day the river was pretty straight, and consequently the current travelled faster; in fact, it may be taken as a general rule, that the more sinuous the river the slower the current, since the more the river winds the greater is the proportion of its total energy which is lost through friction against the winding banks.

November 13th. Drop,  $\pm 0$ ; transparency, 3.4 cm. at 7 a. m., and 5.9 cm. at 1 p. m. The banks were 2.44 m. high; and the high-water level 1.81 m. above the existing level. The windings were not particularly difficult at the start, but got worse as we went on; and the rate of flow was fairly sluggish, though even then the current moved faster than it had done during the preceding stage. Kamisch steppe immediately adjacent to the river, and thick poplar woods a little way back



from it on both sides; though between Intschkä and Kök-tschol it is only young forest. At Simlik, a short distance from the right bank, the people of Ak-arik near Schah-jar, to the number of about a hundred families, have made a summer colony for growing wheat; but the winter they spend at home in Ak-arik. The next district on the left is called Jigde-tschakil, and the next on the right Boba-jarsuk, with a small detached lake. Then comes, on the same side, Mantscha, and, on the left, Jol-bars-baschi, where we again came into contact with my route of 1896. In a sharp bend to the north the Tarim picks up the mouth of the Intschkä-darja, though it has not a drop of water. Its bed, some 25 m. wide, terminates in two channels, or rather a single bifurcated channel, and its bottom, which was still moist, lies

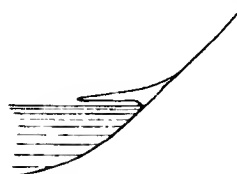


Fig. 96. FRINGE OF ICE.

fully 1 m. above the level of the Tarim. Hence, if at this season there had been any water in the former, it would have poured into the mother stream down a cascade. In summer, however, when the high water raises the level of the Tarim, the latter sends its water up the Intschkä-darja. Finally, we had, on the left, Kök-tschol, and, on the right, Lanka. We now observed on those parts of the river-bank which look towards the north, and consequently are in the shade, the beginning of a fringe of ice, 1 to 2 dm. broad, 12 mm. thick, and 1 cm. above the surface of the water; indicating that it had been formed one or two days before, when the level was somewhat higher, and it was being constantly strengthened and increased by the miniature swell set up on the river by the wind. The ice was intermingled with sand and silt, and formed a prolongation of the slope of the bank. At the extremities of the little detached bays the ice was as yet only two or three mm. thick, and was continually being broken by the movement of the waves.

November 14th. A rise of 0.5 cm. Transparency, 3.8 cm. at 7 a. m. and 5.1 at 1 p. m. The banks were 3.0 m. high; and the high-water level 2.14 m. above the existing level. The river continued pretty winding; the woods were precisely like those of the day before, except that towards the end of the day tamarisks predominated. In the morning there was ice even on the river in the quiet space between our two ferry-boats; and we also met with the first patch of drift-ice, though

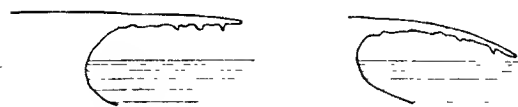


Fig. 97. FROZEN SURFACE OF ALLUVIAL DEPOSITS.

in all probability it was simply a fragment cut out of some quiet embouchure. The banks were frozen so hard that the oars striking against them produced a scraping sound, indeed they almost rang like metal. The frost had seized them in the precise positions that they occupied the day before, so that pieces which we had observed as being just on the point of falling now stood stiff and firm. But though thus hard above, the foundations were still soft and insecure, and were being continually washed away by the river. The alluvial deposits were only frozen on the surface, with the result that their outer edges, undermined by the current and softened by the greater warmth of the day, gradually bent over, giving rise to hollow arches and domes, which later on in the day's journey broke off and dropped into the stream.

Here again there are three old river-beds to the south of the Tarim, although the reports concerning them are as usual uncertain and contradictory; but they are said to lie 1, 2, and  $2\frac{1}{2}$  days' journey respectively away from the river, and to be in every case almost embedded in sand. All three, too, are dry; the middle one is called the Arka-darja, the other two bear the same name, Atschik-darja. On the left bank of the Tarim, or Ugen-darja, stands the masar of Hadschi Nam, which I have mentioned in my previous journey; and on the right Kalta-bel. In a dense poplar wood at the head of a north-going loop there is a satma; and we noticed one canoe. The region is inhabited by shepherds, who, however, are so shy it was impossible to get speech of them. The next tract on the right is Atschal. On the left, a little back from the river, stands the masar of Sultan No Aravattam Busrugvar, with a *mätschit*, or »mosque». Other names given to the right bank are Öketsch-kotan and Atschal. At Tupe-teschdi, which will be familiar to readers of my former journey, the river was 41.10 m. broad, and had a mean depth of 2.218 m., a mean velocity of 0.7568 m., and a volume of 68.99 cub.m. in the second, or an increase of close upon 6.0 cub.m. since the 9th November. Here too, there were shepherds. By this both the wild-geese and the wild-duck had entirely disappeared; the last wild-geese we observed winging their way westward passed overhead on the 12th November.



Fig. 98. 

1.44	2.69	3.47	3.48	3.16	2.78	2.42	2.31	1.95	0.70	= depth.
39	59	88	89	104	98	96	90	76	42	} velocity.
32	72	78	92	94	100	99	84	79	32	
36	59	79	93	81	99	90	78	66		

Breadth = 41.10 m. Tupe-teschdi, November 14. Scale 1 : 500.

November 15th. Drop of 1 cm. Transparency 5.9 cm. at 7 a. m. and again at 1 p. m. The banks were 3.20 m. high, and the high-water level 2.60 m. above the actual surface. Just below our camp there was on the left a canal, the bottom of which was a good 2 m. above the actual level of the Tarim, so that the water could not possibly reach it except at the season of high flood. Beside it stands a conical arrangement of poles, marking the spot where the boundary between the provinces of Schah-jar and Kutschar strikes the river. To the east of that point the rights of pasturage belong exclusively to the shepherds of Kutschar. The corresponding boundary mark on the right bank is fixed somewhat lower down the river. At Kälalik we found an unusually large and well equipped station, with several *kotans*, or »sheep-folds», but the inhabitants all took to flight upon our approach. The next names that occur on the right bank are Atschal and Kök-köl; at the latter there are two small lakes remaining in an old bed of the river. Along the south side of this disused watercourse are poplar woods; although in this part of the river's course the predominant vegetation consists of steppe and tamarisks, the latter frequently standing on their characteristic mounds or on sand-dunes. At the south-east angle of the last bend to the south the river gives off a rather important

arm, which has cut its way deeply into the ground, and carried even then a pretty lively current. This, which is evidently the commencement of a new arm, rejoins the Tarim below Kade-dung. In the summer it is reported to be quite a powerful stream, and to flow at all times more swiftly than the mother river. Its volume at the time we passed it was probably equal to one-fifth of the full volume of the Tarim, and its current was then more rapid than the current of the latter, — another circumstance pointing to its being the commencement of a new channel. At Kudsche-käldi, beside the last loop which the river makes towards the north, the current is turned sharply back, through a very acute angle, by a belt of tamarisk-grown sand-dunes which lie right across its course. These dunes are built up on horizontal clay soil in layers of varying thickness and consistency, and are in places intermingled with salt. Their lower parts have been washed away by the stream, and in consequence of their being still held together by the ramifying roots of the tamarisks, they plunge steeply down into the water. Although none of them exceed 4 m. in height, still, owing to the uniform flatness of the country, their summits command an extensive and uninterrupted view in every direction. South and south-east

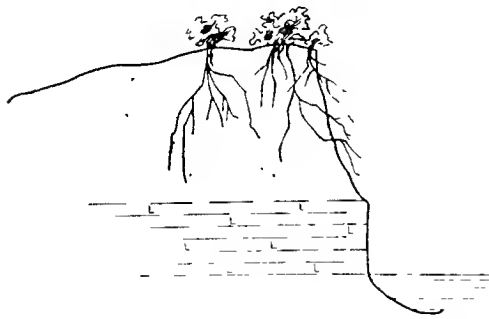


Fig. 99. DUNE WITH VEGETATION, RESTING UPON HORIZONTAL CLAY.

lie two small lakes, fed probably by the branch which is given off at K  k-k  l. Otherwise in every direction the one universal feature is the unending yellow steppe, interrupted at intervals by small clumps of poplars or belts of tamarisks. The forest is both sporadic and thin; nowhere do the trees form continuous woods. But although we passed several huts and a canoe, the country was entirely uninhabited. At Kade-dung there are two or three isolated sand-dunes, reaching an altitude of 8 m. and set about by a dozen pop-

lars. The ice in the quiet corners and reaches of the river was now strong enough to bear our dogs. I am speaking only of the detached sheets of water; there the ice had now definitely formed for the winter, and no longer thawed during the day.

November 16th. The drop was  $\pm 0$  cm.; the transparency 5.0 cm. at 7 a. m. and 5.5 cm. at 1 p. m. The height of the banks was 2.81 m.; the high-water level, 2.22 cm. The names on the left bank are successively Ghas-asti, Jigde-tegisch, and Sarik-buja, the last-named with a satma and two canoes. In its vicinity I encamped in 1896. On the right bank lies the district of Siksan-k  t  k; and just below it K  k-k  l-atschal, where the Tarim again gives off the K  k-k  lning-akini. A little below that, again, another small branch breaks away from the river and becomes lost in the forest; it only carries water at high flood. During the day the river was winding and sluggish, and it was seldom that our punting-poles, although 6 m. long, were long enough to reach the bottom. Every now and again the river contracted for short stretches into a sharply-defined channel, destitute of alluvial deposits. Steppe and tamarisks were still predominant, the poplars occurring in small clumps only. Although huts were not at all uncommon, we only met with shepherds at one place. Our camp, pitched over against the district of Daghi, was said to be only two or three kilometers distant from an old river-bed known as the Kona Ugen-

darja. This artery starts at Jigde-tegisch, and a baj of Sarik-buja, about 45 years of age, remembers, when a boy of ten, quite well seeing the great river flowing along this old bed through the midst of the big poplar woods, which still inclose it. But about thirty years ago a side branch, like that at Kök-köl, burst through the right bank, and into it the main stream has gradually made its way. In the old bed, which contains the lake of Tschark-asti-köl, there was still a little water as late as 1896 when I travelled beside it, under the impression that it was the principal stream, and in 1895 it had had quite a respectable current flowing through it. Now, however, its upper part is filled with clay and silt, and is dry for the greater part of the year, though its lower extremity generally contains a little stagnant water. Thus here, again, we have an instance of the river's tendency to shift to the right.

From this locality to the great sandy desert it is stated to be half a day's journey on horseback, but to the Atschik-darja (Arka-darja?) a day's ride, so that this mysterious watercourse must actually run through the desert. The natives expected the river to become permanently frozen in about 25 days, or, say, about the 12th December, and they calculated that its surface would stand some 60 to 70 cm. higher than it did then. After strong ice has formed all along the margins of the stream, there is generally for some days a narrow strip of open water in the middle, where a slow current flows. The melting of the ice in spring, after an interval of 2½ months, always gives rise to a freshet flood of great volume and power. Seeing that we were given the same explanations all the way down the river, it can no longer be doubted that this spring flood must be one of imposing magnitude, and that, owing to the increments it receives on the way, it must increase in volume as it advances down the river. Still, the rise cannot very well be exceptionally noticeable, as indeed we shall see lower down, because of the large quantity of water that is drained off all along the river to fill the numerous marginal lagoons which accompany it. Thus the considerable spring flood of the Kara-koschun is plainly derived from those tracts of the lower Tarim that lie nearest to it.

The baj of Sarik-buja mentioned above owned 2,000 sheep, and he told me, that there were 150 to 200 shepherds, with their families, between Sarik-buja and Dung-satma. Hence in this quarter, too, the sheep-breeding industry is in a flourishing condition. Most of these shepherds are said to keep to the immediate vicinity of the river in winter only; this explains why we found so many huts unoccupied. During the rest of the year they range beside the Intschkä-darja, the Tschark-asti-köl, and Dumbol, or even penetrate the southern transverse valleys of the Tien-schan.

Tigers are quite common in this part, and we frequently saw their tracks beside the paths. They are caught by means of a spring-trap (*kapghan*, *tosak*), placed over a hole about 1½ m. deep, and hidden under branches and leaves. The illustration on the next page shows how this ingenious instrument is set. The two rows of sharp, interlocking teeth are brought smartly together by means of two strong springs. When the trap is set, the two wings, with the teeth, are held flat down on the ring which constitutes its framework, and there are kept in position by means of a cord, drawn diametrically across the ring, and held by a couple of pins fixed round the framework and one wing in such a way that, when the tiger treads upon the

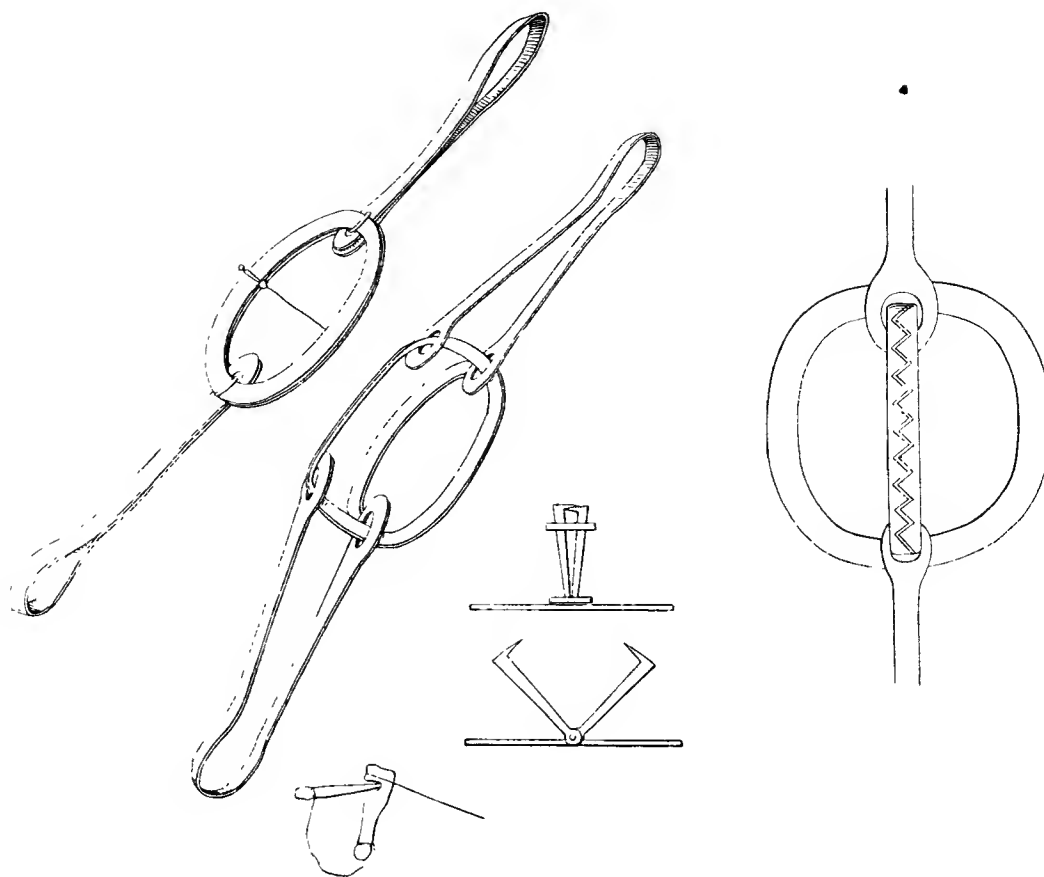


Fig. 100. A KAPGHAN OR TOSAK.

trap, the cord is automatically set free from the pins, and the trap »goes off». Different sizes of these *tosak* are in use throughout East Turkestan; the smallest being employed for catching hares, the next larger size for foxes and wild cats, the largest, which are very heavy, for tigers. This beast is sometimes left a week in the trap before it is shot.

November 17th. A drop of  $\pm 0$ . Transparency, 3.6 cm. at 7 a. m., and 6.9 cm. at 1 p. m. The height of the banks, 2.83 m.; high-water level, 2.31 m. The river serpentine, though not so badly as at its worst; but it was a great deal narrower than it had been before. The poplars were rather more plentiful, and in places even formed forest; all the same, the prevalent vegetation was steppe plants and tamarisks. The hydrography of the region is extremely complicated. My guide, a hunter, a man who knew what he was about, and whose calling made him familiar with all the woods of that region, gave me the following information. South of the district of Ghischi-kotan, on the right bank, is the Tschong-hasanak-darja, which derives its water from the main river (see below). Its course is to the south-west, but it comes to an end immediately south of Ghischi-kotan, thus forming a sort of fluvial *cul-de-sac*, or stagnant arm, with a chain of small lakes still remaining in it even in the late autumn. The only inhabitants on its banks, which are planted with forest, are the hunter and his family. Its water is always fresh, owing to its being renewed yearly from the big river.

Fig. 101. A MAP OF THE REGION, WITH COMPLICATED HYDROGRAPHY — DRAWN BY A NATIVE.

where however it is choked with silt, but that it is in part also fed by the Schah-jar-darjasi; in any case its course runs parallel to that of the Tarim. Its lower reaches still contain some stagnant water. The name which the Lopliks, or men of Lop, give to the Intschkä-darja is Tscha-jan. All these various fluvial arteries form an inextricable network of parallel watercourses, some of which at all events are of a merely transitory character. This year one may be the largest, next year its neighbour. But all lying on the same plane, they are very sensitive to the formation of sedimentary deposits, to the growth and decay of vegetation, to winds, and to drift-sand. Hence there is nothing surprising in the fact, that the information which I gleaned in 1899 differed in a few particulars from that which I was told three years before. This intricate inland delta, if I may so call it, is incessantly changing. The Tschark-astiköl derives its water from the river by two arms; the first of these we passed in the first northerly bend that the river made after we started in the morning. The lake, which I should rather call a reed-grown marsh, is very extensive, and is sur-

rounded by poplar woods. Out of its north-east corner issues an arm which goes to join the Tscha-jan, a kind of indirect bifurcation. Two other small arms lead out of the second north-going loop, which is very sharply rounded; both of them lie considerably higher than the existing level of the Tarim. Both, however, soon flow together again, and, picking up the first-named, enter the Tschark-asti-köl, situated pretty close to the left bank of the Tarim. The name of this district is Kum-jejnek. The lake just spoken of discharges part of its overflow water into the Tarim by means of a connection which we passed in the third loop of the day; the remainder enters first a smaller lake, the Kijak-köl, and issuing from it as the Töttör-akin finally disembogues, under the name of the Jigdelik-akin, into the Tscha-jan.

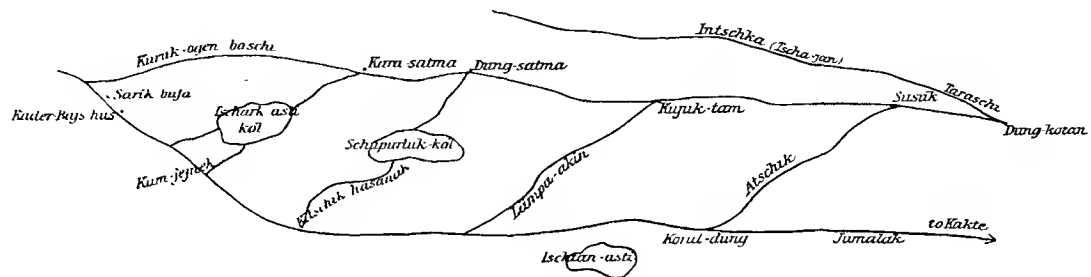


Fig. 102. PART OF THE SAME REGION DRAWN BY ANOTHER NATIVE.

On the right we passed, at Daghi-kotan, a very sharp loop, which the river had abandoned the year before, by cutting through, in the usual manner, the narrow neck of land at its base. Although poplars grow on the margins of the loop, there is no water in its bed. At its lower extremity are some sand-dunes bearing vegetation. At Kosch-kotan, where there are two huts, the mouth of the arm mentioned above, the Tschong-ögen, is distinctly perceptible, although it was at that time dry. This again splits into two, one division being that already stated to travel west-south-west, while the other, the Kara-akin, goes towards the east-south-east, and then reenters the main stream. Neither of these carries water except in the summer. Yet another arm, the Kitschik-ögen, likewise carrying water at the summer flood only, leaves the river at our camp, and after passing near the east end of the Tschark-asti, enters the lake of Schupurluk, whence it issues, to unite with the Kuruk-ögen at Dung-satma, this being quite a distinct place from Dung-kotan. This stream, the Kuruk-ögen, quits the big river just above Sarik-buja; the reason why it is called *Kuruk*, or »dry», is that it only carries water at the season of high flood. In its lower part, however, there is water constantly, and there it is known as the Kitschik-ögen, or Little Ögen, in contradistinction to the Tschong-ögen, or the Big Ögen, or to the Ögen simply, as the existing river is called. A portion of the water of the Tschark-asti also enters the Kitschik-ögen at Kara-satma. Here, again, I was told, that the Baba-köl and the Sarik-kamisch no longer exist.

November 18th. A rise of 0.5 cm. Transparency, 5.1 cm. at 7 a. m. and 4.6 cm. at 1 p. m. The height of the banks 4.0 m., and the high-water level 3.10 m. The hydrographic relations still continued complicated. Soon after starting we passed a small curving bend a year old, and containing a lake. From the same side,



*Lynce. A. B. Lagrelins & Westphal.*

KORAL-DUNGNING-KÖL. VIEW LOOKING S.E. FROM KORAL-DUNG.





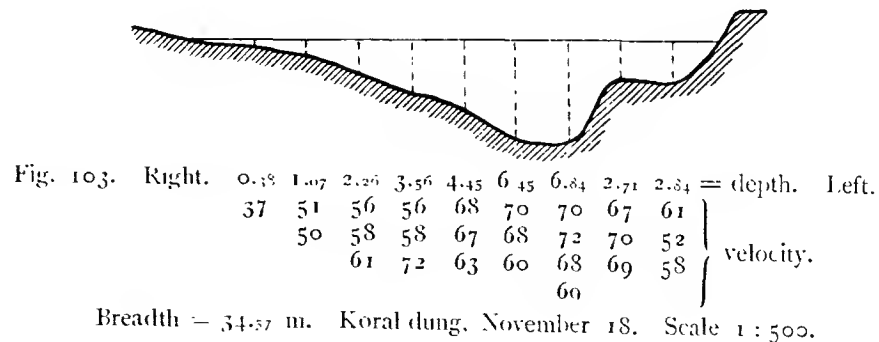
too, there issues another arm to the adjacent lake of Ischtan-asti-köl, which is shallow and overgrown with reeds, as well as encircled by steppe and a narrow belt of continuous sand-dunes. On the left another arm goes off to the Tschanga-köl, a lake without any outflow; that is to say, it is a marginal lagoon, which rises and falls in sympathy with the river, and, when the inflow is stopped, shrinks through evaporation. After that comes yet another out-going arm on the same side, namely the Lämpa-akin, which was then taxing the mother river to the extent of about 1 cub.m. of water in the second. This joins the Kitschik-ögen near Kujuk-tam, where-upon the united stream again bifurcates. Of the two branches into which it divides the left-hand one first passes through the large lake of Ak-jasuk, then proceeds to Dschaj-dung, and, intersecting the road to Bughur, continues on to the large lakes of Chodschak-köl and Sädik-akin, both situated farther to the east. After that it again bifurcates, sending one branch through the forest tract of Bostan to the Tscha-jan and the other to the right-hand arm of the first bifurcation of the Kitschik-ögen, and the united stream then travels eastwards, past Dung-kotan, to Taraschi, where it, too, rejoins the Tscha-jan, or Intschkä-darja.

South of the beginning of the Lämpa-akin lies, on the right of the river, the lake of Jäkän-köl, which obtains its water partly from the Ischtan-asti-köl, and partly from the river direct, in that the kamisch expanse is here inundated by the summer overflow. To the south of these lakes runs the Kara-akin, here split into two branches; the left-hand branch enters the Jaghatschlik-köl, while the right-hand branch, after traversing the Karaune-tokkan-köl, joins itself to its sister branch. After that the reunited stream, still retaining the name of Kara-akin, picks up a feeder that issues from the Koral-dungning-köl, and empties itself into the Ak-kumning-jughan-köl. This lake, as its suffix *jughan* (i. e. »big») indicates, is of large size; and it is, moreover, surrounded by white drift-sand, and derives its water from the Jäkän-köl by a connection which traverses the forest-track of Jalghus-toghrak.

The boundary between the administrative districts of Kutschar and Lop (Dural) passes through Koral-dung, and it was there we first encountered the fishermen of the Loplik race. The top of the consolidated sand-dune of Koral-dung, about 10 m. high, commands an extensive view of that flat country, so plentifully watered by the capricious ramifications and overflowings of the Tarim. Koral-dung, I may remark, is equivalent to Karaul-dung, meaning the »watch-hill», because it is there that the boundary passes. The nearest feature in the view from its top is the bright, greenish-blue surface of the Koral-dungning-köl, its thin crust of ice half broken up by the gentle wind. The lake is set about by tamarisks, standing on mounds of kamisch, these being so tightly packed together as to be quite impenetrable; in fact, the tamarisks were like little islets and holms studding the oceanic expanse of reeds. As for the poplars, although there were very few in our immediate vicinity, they made quite dense woods in the neighbourhood of the Jäkän-köl, the Karaune-tokkan-köl and the Jaghatschlik-köl. The surface hereabouts was still moist from the last overflow of the high-water; indeed, when the waters are out in summer, it is possible to paddle a canoe through the reeds over parts of the shore which were then dry land. Of the other lakes mentioned above there was not a

vestige to be seen, and of the great river only the extremities of its nearest windings. The remainder of the inundated country was hidden by the all-pervading reeds. It is no easy task to map a country such as that. You can only feel quite sure about the river itself and the tracts immediately contiguous to it. The more distant features, as well as those that are masked by the conformation of the ground, can only be entered from description, and consequently can only be dealt with in outline. Now, as we have seen, there extends in this region on both banks of the Tarim a broad network of intricate, anastomosing watercourses, channels, branches, marshes, swamps and lakes. These last were, at the season of our visit, almost without exception cut off from the river, though as a rule still pretty full of water, surviving from the copious overflows of the summer. The channels, however, which connect them with the river and through which their supplies of water are contributed, were at that period dry, and their beds lay for the most part one meter or more above the existing level of the Tarim; so that these marginal lagoons levy no contribution upon the river at the autumn season. This circumstance, taken in conjunction with the actual rise of the river at that period, explains the almost constant volume of the Tarim, or rather accounts for its slow subsidence. Were it not for these circumstances, the river would fall at a much more rapid rate in consequence of evaporation, absorption into the ground, and the drain of this or the other still flowing channel, such as the Lämpa-akin.

At Koral-dung its dimensions were as follows: breadth, 34.57 m.; mean depth, 3.056 m.; mean velocity, 0.6010 m., and volume, 63.49 cub.m. in the second, or only 5<sup>1</sup>/<sub>2</sub> cub.m. less than on 14th November, although the Lämpa-akin alone deprived it of an appreciable quantity of its volume. The river was now greatly contracted: at Koral-dung the extreme breadth at the time of high-flood was barely 70 m., but of this not more than 34.57 m. were covered by the actually flowing water. The stream which had shrunk in this way is, it will be remembered, the powerful Ak-sudarja, augmented by the Jarkent-darja, the Chotan-darja, and the Schah-jar-darja. The river was however far less sinuous than it had been in the preceding section.





*Linstr. A. B. Lagredius & Westphal*

THE TARIM RIVER. VIEW LOOKING N.E. FROM KORAI-DUNG.



## CHAPTER VIII.

### THE JUMALAK-DARJA TO TOKUS-KUM.

Lower down, in the district of Atschal, where the river describes two loops to the right, a branch called the Atschik leads off through the opposite bank, and at Süsük unites with the Kitschik-ögen (called the Kuruk-ögen in its upper part), which in its turn mingles with the Tscha-jan at Taraschi above Dung-kotan. Except for a stagnant pool or two, the upper part of the Atschik-darja was then quite dry, though in its lower course there was enough stationary water to reach up to a horse's saddle-girths. This was of course a survival of the high-water overflow of the previous summer, though, as it happened, this had been less abundant than usual; so that we may perhaps look upon this Atschik as a moribund artery. At the right side there were here two abandoned loops.

From this point the great river is called the Jumalak-darja, or the Round River, a name bestowed no doubt because of the sweeping curves which it proceeds to describe. Next on the right we have the Ak-kunning-jughan-köl, the most extensive of all these marginal lagoons, — in fact, it is so broad that a man, shouting on the one shore of it, could not be heard on the opposite shore. On the left the country is called Tschong-aral or the Great Island, owing to the fact that it is embraced by the Kitschik-ögen, the Jumalak-darja, and the Atschik-darja. At our camp, Tschong-aralning-toghrighi, a fluvial artery, the Kakde-darja, struck out southwards, but having been for several years disused, it has in the interval become choked up again. It was down this watercourse that the Kara-akin formerly sought its way back into the main river; now however it crosses it and continues on farther to the east. One of the districts beside the Kakde-darja is known as Töttör-kotan. Here about thirty years ago a big *togh*, or »dam», is said to have been constructed for the purpose of retaining the water in its ancient channel. A pretty long way to the south there is said to be another old watercourse, known as the Opghan; this, embedded amongst the drift-sand, is no doubt identical with the Atschik-darja or the Arka-darja.

After leaving Atschal the river again alters its character, in that it becomes extremely narrow; in fact, it bears a close resemblance to the terminal portion of its course just above Tschegelik-uj. It is for all the world like a dug canal, inclosed between banks which in general are 2 m. high, covered with an extraordinarily

dense growth of reeds, and frozen as hard as a stone even during the day. Here there is of course no room for alluvium to accumulate; the river-bed is, in fact, a gully, deeply trenched through the sandy soil, and drawn in an unusually straight line towards the south-east. The greatest depth we measured along this stretch amounted to 6.84 m., though in one place where the river-bed contracted to not more than 20 m. in width, the depth could hardly be less than 8 or 9 m.

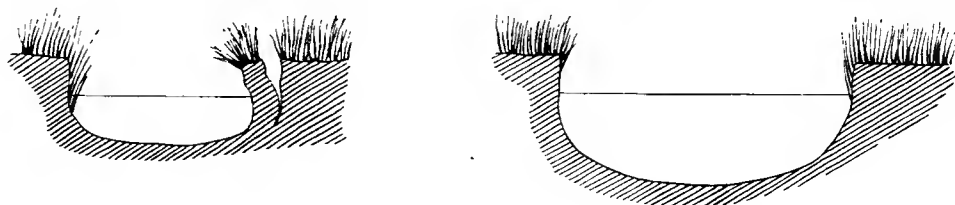


Fig. 104. SECTION OF THE NARROW RIVER BED.

November 19th. Rise = 3.5 cm.; transparency 4.7 cm. at 7 a. m. and 5.0 cm. at 1 p. m. Height of the banks, 2.50 m.; the high-water level overtops the banks, and consequently could not be measured.

This day we again passed a long chain of marginal lagoons. In fact it may be laid down as a general law, that the tendency to form marginal lagoons of this description increases as the river advances towards its termination. In other words, after a short section, in which the stream traverses a newly formed channel, the tendency becomes most pronounced in those parts of its course in which it flows towards the south-east and south, just previous to its becoming lost in the terminal labyrinth of marshy lakes.

The river still continued very narrow, and for long distances was devoid of alluvial formations; while those which were deposited in other localities consisted of narrow crescentic strips, under the banks on the convex side of the loops. This circumstance seems to be in a measure connected with the presence of marginal lagoons, for it is precisely where alluvial formations are absent, and the river is contracted, that it overflows its banks, and so helps to fill the lagoons. In some stretches the river pursues a perfectly straight course, and its windings are short, though very abrupt, 180° or more. The velocity was well maintained. Immediately adjacent to the river-bed were belts of impenetrable reeds, and behind them tolerably thin, but dry and tangled, toghrak woods. Occasionally there was a solitary poplar, sometimes actually growing in the water, or hanging out over the current from the bank. In other places, where the banks were riven, so that portions were threatening to fall into the stream, the thick reeds pointed horizontally out over it like plumes.

At Kum-arik a small artery, filled at the period of high water, leads off to the right into the Kakde-darja; and after it comes the artificial canal of Tatlik-mejsen-arighi, named after the man who dug it, and connecting with the elongated lake of the same name. This lake is likewise fed by two other connections, one a natural channel, the other a canal, Muhamed Niasning-arighi, it, too, named after the man who made it. South of the lake comes a belt of sand, and beyond it the Kara-akin, its banks shaded through out by poplar woods. On its way it picks up an arm that issues from the east end of the lake of Tatlik-mejsen-arighi. On the

left we passed the small lake of Ukar-tokkan-köl, apparently fed by overflow water. North of it stretch the sandy belts of Peghan-kum or Palevan-kum, Bel-kum, and Jaman-osa, and on the other side of them the Atschik-darja makes its way north-eastwards to Süsük.

Lower down we left on the right Kara-tschilan, a Lop village, with several clay houses, and wheat-fields watered by a canal from the Kara-akin. This stream continues on towards the east, leaving on the left the Tüplik-köl and, further along, the Partschalik-köl. North of this, and quite close to the right bank of the Jumalak-darja, lies the lake, or rather marsh, of Toghralik-köl, apparently a depression, temporarily filled with overflow water, for there are poplars growing in it. The spaces between these lakes are filled with strips of sand and tamarisks. South of the Kara-akin there is an old watercourse, the Tschighanlik, which lower down coalesces with the Kara-akin, and is said to contain a few pools in its lower extremity.

The next name on the left bank is Buja-tscheke. A short connecting channel links together the river and the lake of Jäkänlik-köl, and near the latter is a belt of sand known as Musa-utschanghan-kum. Several roads radiate from the village of Kakde. For instance, one crosses the river to Bughur, whence another leads to Schah-jar; yet two other roads connect the first-named with Dural, lower down the river, one running along each bank, that on the left bank passing through Karaul. The village of Kakde is inhabited by seven families, the wealthiest of which owns 2,000 sheep, the next wealthiest 500 and the rest about 100 each.

These Lopliks live to a very great extent upon fish, which they catch in nets in the marginal lagoons that are cut off from connection with the river, and also in the small bays which are formed on the inside of the lower part of each alluvial deposit. They cultivate, in addition, wheat, maize, and melons. Their irrigation water they draw, not from the big river, but from the Kara-akin, which flows close past the village. Some thirty years ago the principal man of the village, Muhamed Karaultshi, put a dam across this stream, and so turned the high-water (end of July to beginning of September) into his own canals, whence it is distributed over his fields. The dam requires repair almost every year. The villagers possess their *jajlaks*, or »summer grazing», beside the lake of Dschindar-köl, where they have built themselves some slight summer huts. The old man had in his time killed there no less than seven tigers. All the riverine population below Koral-dung are subject to the *amban*, or Chinese governor, of Dural. Their fiscal obligations do not consist in the payment of taxes in hard cash, but in rendering contributions *in natura*, such as sheep, fish, tiger skins, and firewood. Thus the inhabitants of Kakde are a versatile people — keepers of sheep, agriculturists, and fishermen all at one and the same time, and yet they are, as it were, semi-nomads, in that they dwell at a different place in summer from what they do in winter. Similar conditions are found amongst the riverine population lower down, only there agriculture and sheep-breeding are less important, while fishing may be considered as the mainstay of their livelihood.

At Kakde the prevailing winds are said to blow from the west, and early in the spring the atmosphere, which then grows thick and heavy, begins to discharge quantities of fine dust — the same phenomena that I observed beside the Kerija-darja in the early spring of 1896. At this time many of the sheep get »strangles»,



and some of them die. Some snow falls in December and January, the clouds coming from the north; but the snow seldom lies a foot deep. In the summer it sometimes rains, though the showers are always short, and very rarely violent.

The Kara-akin, after passing through the lake of Dschindar-köl, continues to flow to the east. On the north this lake is bordered by a strip of sand bearing the extraordinary name of Läschkär-sokuschan-kum, or the Sand where the Armies Fought together, possibly pointing to some legend now forgotten, or more probably the name is due to a mere tradition.

November 20th. A rise of 2.8 cm. Transparency, 5.1 cm. at 7 a. m. and 5.6 cm. at 1 p. m. The banks were 2.41 m. high, and were overtopped by the summer high-water. Throughout the whole of the day the river was accompanied, all along its north side, by the long, narrow lake of Mandschar-köl, which is fed by the Jäkänlik-köl. Between it and the river stretch broad beds of kamisch, and beyond it to the north a belt of sand called Kala-ölgän-kum, where there is a small village, Kala-ölgän-uj, inhabited by fifteen Loplik families. Dung-kotan lay due north of us, but it was at this time uninhabited, its people, to the number of 25 families, having flitted to Süsük. A forest belt beside the river here is called Kujuk-tam. On the south we had a small patch of sand, and a »high-water» arm, which empties into Dschindar-köl. The name Kutlekmetning-uj, given to a tract adjacent to the river, is derived from the attempt of one Kutlekmet to found a new colony — an instance of the way in which new names get established along the river-side. The Tarim flows at first north-east, making many sharp turns; then it bends to the east, and finally to the east-north-east, the last stretch being extraordinarily straight. The banks are predominantly steppe, with a thin sprinkling of poplars. The river-bed is still contracted. Just above our camp it was connected by a linking channel with the Mandschar-köl. When the river is brimful, it discharges its surplus water into this lake; but when the lake, which is, as I have stated, fed also by the Jäkänlik-köl, stands at the higher level, it empties itself by the same channel back into the Tarim. South of the camp is the beginning of the lake of the Utsch-uj-köl, fed by an artery that carries water in summer only. On its north shore it is edged with kamisch, while poplars are the characteristic feature of the south shore. Beyond it in the latter direction stretches the sandy desert. Jigdelik-köl lies north-east of our camp, which bore the name of Käsčik, or the Ford, owing to the fact that the river is there crossed by the highway from Kakde to Karaul. These fords are always situated on such parts of the river as are straight, broad, and shallow. A Loplik, who was well acquainted with that part of the country, sketched for me in the sand with a piece of stick a rough map of the portion of the river we had just traversed, and its immediate surroundings. Of course so rude a sketch could not do more than indicate approximately in outline the tangled labyrinth of the local waterways. To have visited, and personally examined, each of these numerous small marginal lagoons in turn would have demanded an immense amount of time. Indeed it would have been hardly practicable, and when done, the result would have possessed little more than an ephemeral value. We have seen how the river repeatedly alters its bed, and with each such migration corresponding changes are made in its accompanying lakes and lagoons: they dry up,

Pl. 19.



*Illustr. A. B. Lagvelius & Westphal.*

THE LOOP OF TSCHONG-OTAK (JUMALAK-DARJA), NOV. 22ND.

View from the Left Bank, looking N.N.W.



shift their position and are reformed in other situations. Besides all this, the configuration of the country is such as to make it extremely difficult to travel across it; both dry land and lagoons are so overgrown with reeds, that mapping would be the reverse of easy. To examine it on foot would be extremely difficult, while canoes are only of use on the lakes and lagoons.

For a considerable distance from and below Kätschik the river-bed is only four years old. Hence its course lies through a desolate region, where there are but few names to record; and as the new, rapid, and muddy stream is little suitable for fishing, its banks are seldom visited by the Lopliks. The old (former) river-bed lies to the north, that is to the left, and has been the chosen highway of the stream for a period of 40 to 50 years, or as far back as the older men of the locality are able to remember. But at the present time its entrance is choked with sediment, and not one drop of water finds its way into it, even at the period of high flood. Its direction is however distinctly indicated by the beds of luxuriant reeds which accompany it; but except for the delicate young reed seedlings, which were just beginning to establish themselves on its sedimentary deposits, its channel is perfectly bare. The new four-year old river-bed was pioneered by a series of lakes, linked together by short connecting channels in the way we have seen exemplified in the case of the Kara-akin. Gradually more and more of the stream found its path along the chain of lakes, until finally the entire volume poured itself through them. And it is quite conceivable, that in a precisely similar way the river will eventually make its passage through the fluvio-lacustrine system of the Kara-akin.

The road from Kätschik to Karaul passes through Toghrak-mähallä (12 families), a place dependent for its water-supply upon small *tschols*, or »pools», in the bed of a



Fig. 105. THE JUMALAK-DARJA OR NEW TARIM, 21 NOV.

now dry canal which comes from the new river; then through Kara-tschumak (9 families), Saldam (20 families), Tschong-mähallä (28 families), Arelisch (18 families), Arghan, Urmet-öldi, Jigde-söru, Jaka-köl, Abbasi-göturmesa, Gharvane-tokkan, Karaul-dung, and Karaul-mähallä. At the last-named the Ögen-darja reunites with the Tarim. The last inhabited place is Arelisch; the river after that flows through a wilderness. The road from Kakde to Bughur, after winding between the Jäkänlik-köl and the Mandschar-köl, touches Kala-ölgän-uj, the Atschik-darja, Süsük on the Ögen-darja, Dung-kotan, Dschaj-dung, Tscha-jan, the Supurlak-darja, Tschong-köbruk, Utsch-toghruk, and finally Bughur. The Dumbol-darja splits into two arms, the Tschong-köbruk on the north and the Supurlak-darja on the south.

November 21st. Rise, 0.3 cm. Transparency, 5.9 cm. Height of banks, 1.84 m., but as the day went on they decreased in height to 1 m., and even half-a-meter, where the river overflowed on both sides. This is no doubt attributable to the newness of the river-bed, and the fact that it is not yet excavated to any great depth, though this is indeed bound to come with time, for the stream flows with great velocity, namely as much as 1.67 m. in the second, so that its erosive force is strongly developed. The presence of the exceptionally high banks beside the piece of new river we navigated on 2nd and 3rd November is due to the surface of the ground being covered with sand, which had to be swept away before the

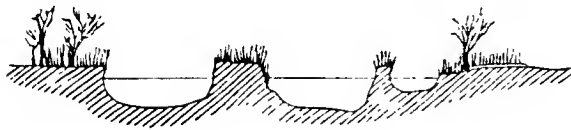


Fig. 106. RIVER BED DIVIDED BY SMALL ISLANDS.

stream could begin to excavate its own proper bed. Otherwise the stretch of river we were then traversing exhibits in all respects the same characteristics as the former portion: it is not deep, but it is narrow and violent, and has no difficult windings, those which do exist being short, though often very abrupt. Just below Kätshik the river divides into two arms for a short distance, the left arm being, however, quite insignificant. Through the right bank a now dry connecting channel, Atschal, is led off to Utsch-uj-köl, and further down another similar one containing a little water. Beyond this last point the river grows still more capricious and uncontrollable, and frequently embraces in its arms surviving fragments of the original ground, in the shape of reed-grown islets. The banks are still fairly densely covered with reeds, arranged in island-like patches and tangled clumps. This *jangi-darja*, like the one I have described before, was plentifully strewn with driftwood, and in several places an entire poplar would be stuck fast in the bottom, with an accumulation of reeds, torn up by the roots, clinging to it on the surface of the current. It is in this way that the reeds are so quickly disseminated through the waterways of East Turkestan. In the case of rivers which have forced a path through the sandy desert, young reeds begin to shoot up at the end of a year or two. We had poplars with us all day long, though only sporadically; some of them were growing in the middle of the river, having been surprised by its sudden appearance, though it will of course not be long before these are washed up and swept away. Most of the trees stand however on the left bank, next the old channel and its accompanying woods. Traces of the former chain of lakes which preceded the new-formed river-bed are distinctly visible on both sides, sometimes in the form of reedy



*Lystr. A. B. Lagrelius & Westphal.*

THE JUMALAK-DARJA AT TSCIIONG-OTAK. VIEW LOOKING W.



sheets of water directly connected with the river, sometimes of moist swampy ground or moist lake basins. The banks themselves were almost everywhere wet, an almost certain result of the summer overflows. The moment the river poured itself through the new »lake» channel, the hydrography of the locality became all at once changed. The shallow lakes were for the most part emptied, or else filled up and dammed back by the masses of sedimentary matter which the river carried with it. The direction of the stream was south-east all day long. A comparison of my accompanying map with the conception which geographers have hitherto had of the middle Tarim will show how immensely wide is the difference between the two. It is plain, that not only I myself, but also Carey and Dalgleish, mistook the Kitschik-ögen for the main river.

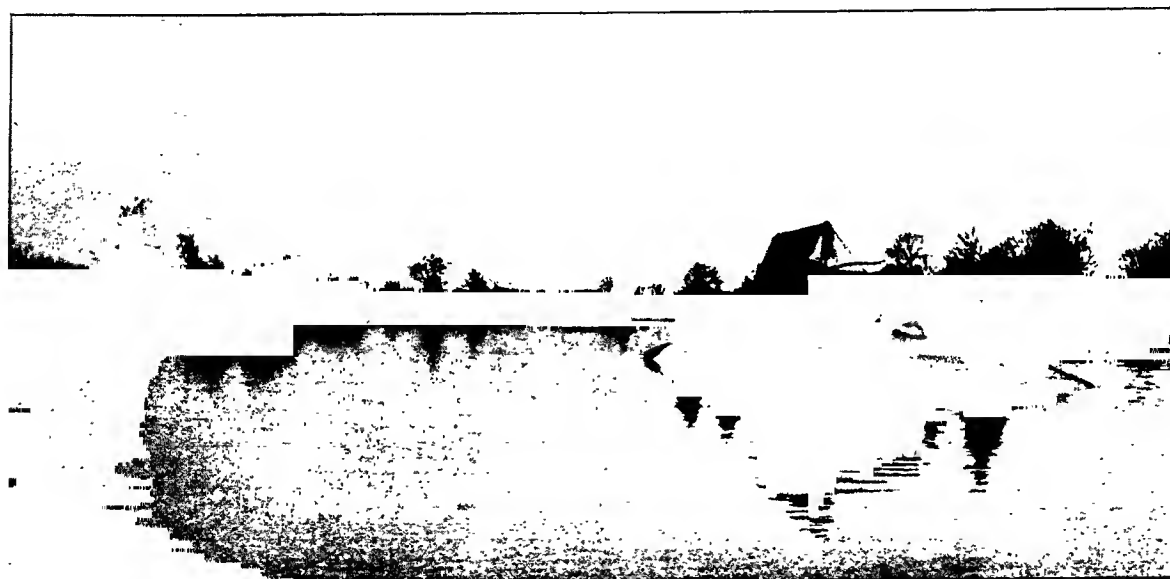


Fig. 107. THE TARIM BELOW KÄTSCHIK, 21ST NOV.

At last we came to the confluence of the Kara-akin, which entered from the right as a gentle current with a volume of two or three cubic meters. Its last halting-place before striking the river is the Utsch-uj-köl; from which lake a secondary arm issues and connects it with the Buja-köl, a lake which for a short distance runs immediately adjacent to the right of the river. This last-named lake, the last of the long chain of lacustrine basins which are linked together by the Kara-akin, and so constitute a connected hydrographical system accompanying the river on the right, ends at the point where the Tarim makes its entry into the sandy desert. At the same time the lake is so close to the river as to be in actual and direct communication with it. The embouchure of the lake is just as broad as the river, and thickly studded with small islets. The Kara-akin began, as we have seen, at Koschkotan on the 17th November. It would, however, be difficult to say whether this system of linked lakes is a new formation, or whether it points to a former path traversed by the big river. But as the way was prepared for the existing *jängi-darja* by the formation of a precisely similar chain of lakes, beginning at Kätschik, it is fair to assume, that the river will eventually make its way into the Kara-akin



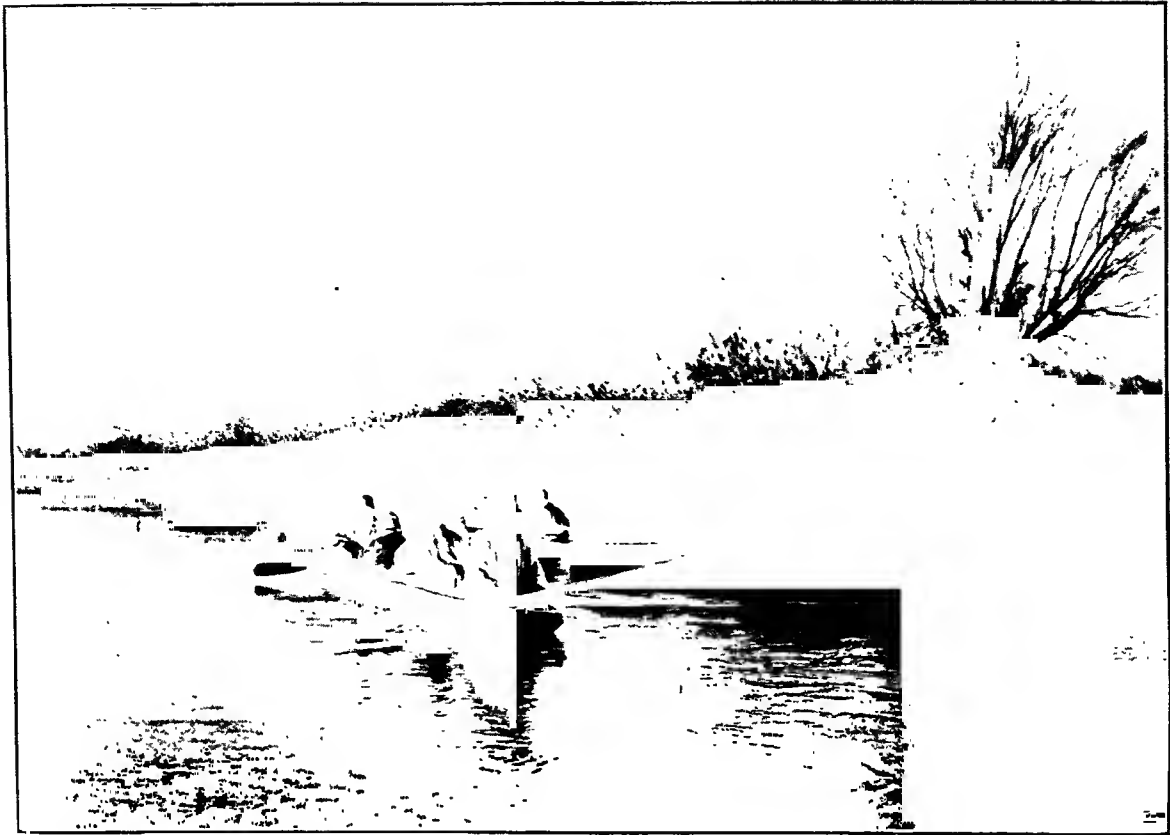


Fig. 108. THE TARIM BEFORE ENTERING THE SANDY DESERT.

chain of lakes. In fact, this would appear to be the characteristic method by which the Tarim shifts its channel in this part of its course: although there is something like a repetition of the same thing in its south-east stretch below Karaul.

We passed on the left the lake of Tongus-atti-köl, which is connected with the river by a dry arm. The old bed of the Tarim, abandoned four years ago, and known, as usual, by the name of Kona-darja, also in this case of Tunnekis as well, is here a very long way from the existing river. The bank lower down is called Imam Naserning-ujj-ak-kum, that is »Imam Naser's Homestead in the White Sand«. Beyond that there is another Kara-akin, which, leaving the river on the left, rejoins it a day's journey lower down.

Meanwhile the drift-sand was closing in upon the Tarim from both sides, narrowing the belts of vegetation which accompany it and interrupting from time to time its still thick beds of reeds; at the same time the poplars became rarer and rarer. In fact, sand-dunes, with tamarisks growing on them, are quite common on the right bank. The transition, where the river does at length plunge into the desert, — East Turkestan's immense »ocean« of dunes — is exceedingly sudden. On the desert side of the boundary-line there is not a single poplar, they all stop short on the west of it. Equally, too, the kamisch comes to an end, and the bare barren sand-dunes shoot down steeply into the water. There are dunes, too, on the left bank, but they leave room for a narrow fringe of kamisch between themselves and the river. At intervals along the foot of the dunes are small strips of silt. Above

Kätschkin-aghis the river, which is now called the Jumalak-darja or Terem, as well as the Tarim, makes its way down some small cataracts. The natives here are acquainted with the name of Jarkent-darja, but not with that of Ak-su-darja. The new bed is as usual called the Jangi-darja and the old bed the Kona-darja.



Fig. 109. BED OF THE NEW TARIM THROUGH THE SANDY DESERT. DUNES ON THE RIGHT BANK. VIEW LOOKING DOWNSTREAM.

November 22nd. Rise 0.8 cm. Transparency, 3.1 cm. at 7 a. m. and 4.0 at 1 p. m. The banks were 0.60 m. high. Our day's journey lay through the outer margin of the great sandy desert. Where the dunes stood in the way, they have been broken down by the irresistible violence of the advancing flood. Against its incorruptible force the sand is utterly powerless. The direction of the river is a straight line due east-south-east, though there are of course a few minor curves. On both sides the sand-dunes are 10, 12, 15 m. high, and frequently quite barren, more especially on the right bank, where they are highest, as indeed might be expected, seeing that it is on that side the desert lies. On the left bank, and sometimes also on the right bank as well, we would perceive an occasional solitary poplar. Tamarisks are, however, pretty numerous, and the reed-belts still persist on both sides of the river, except where they are thrust aside by the sand-dunes approaching to the water's edge. The lower part of these dunes are frequently quite

perpendicular; sometimes indeed they overhang the river. This is due to their being still moist, partly a consequence of the high-water of summer, partly the result of the capillary attraction of the sand. The left bank in many places recedes a little from the river, though never more than a hundred meters or so, and it is then screened by reed-beds. In all this desolate region there was not a vestige of life to be seen, neither man nor animal, not even so much as a raven. It is only very exceptionally that the Lop fishermen visit this part of the river; its water is too muddy to make fishing profitable. The fish prefer the lagoons and the stationary parts, where the water has cleared.



Fig. 110. BED OF THE NEW TARIM THROUGH THE SANDY DESERT. DUNES ON THE RIGHT BANK. VIEW LOOKING UPSTREAM.

On the other side of the strip of sand on the left bank the Kara-akin flows parallel to the Tarim. We noted several small lakes on both sides of the river, and there were no doubt others hidden amongst the reeds — all relicts of former lakes of larger size. At first the river is wonderfully narrow, contracting to little more than 20 m. in width; indeed in two or three places, where it is encroached upon by the reeds from both sides, the open fairway is little more than 10 m. across. At the very beginning of the day's journey a large arm broke away on the right, and was shortly followed by a second; these then form a long chain of lakes, with connecting links, which ran parallel with the river all day. Thus

here again we have the characteristic formation of three parallel channels running side by side, the middle watercourse being the largest. Upon reaching the district of Jar-kum, the southern arm is joined by a branch from the Tarim proper, and then re-enters it, near our camp, by two channels pretty wide apart from one another. This southern arm, as well as the chain of lakes it feeds, is situated in the midst of absolutely barren sand, and forms, as it were, a continuation of the Kara-akin which I have already described as being on the same side of the river. This is, of course, a different stream from the Kara-akin which was now running parallel to us on the left. To have measured the river in a region such as this would have served no purpose whatever, since it was impossible to know whether there might not always be some portion of its stream which escaped one's observation. At Tschong-otak the left-hand Kara-akin is linked to the main river by yet another arm. Here poplars, tamarisks, and kamisch are more plentiful than usual. At Tschong-schakurun the river divides into five arms, all shallow and narrow, flowing round small islets of kamisch, and forming small cataracts. South of the old river-bed lies the lake of At-kojmaghan-köl, the last surviving portion of a former marginal lagoon of considerable extent. After that the sand again gradually wins the upper hand, and the reed-beds become smaller, growing upon so-called *lajdang*, or sedimentary matter which the new arm (*jangi-darja*) has laid down in a former lake-basin. Hereabouts the banks are extremely low, or else altogether non-existent. At Jar-kum the highest dunes that overhang the river are 12 m. high. The northern Kara-akin at length rejoins the Tarim at

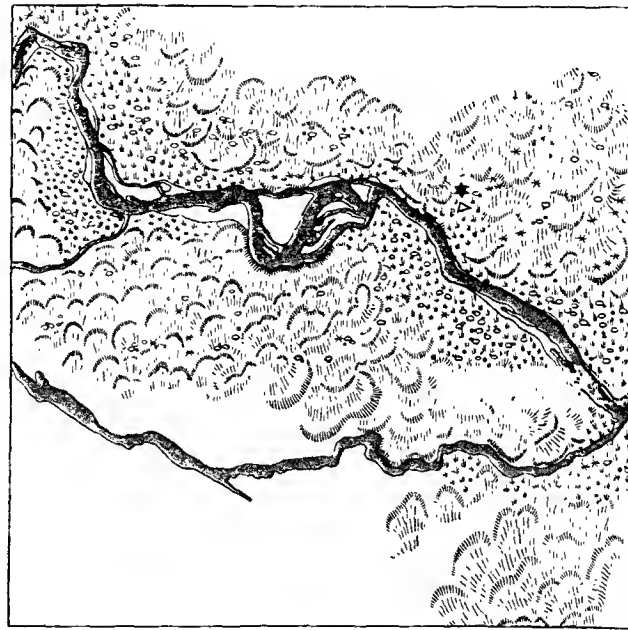
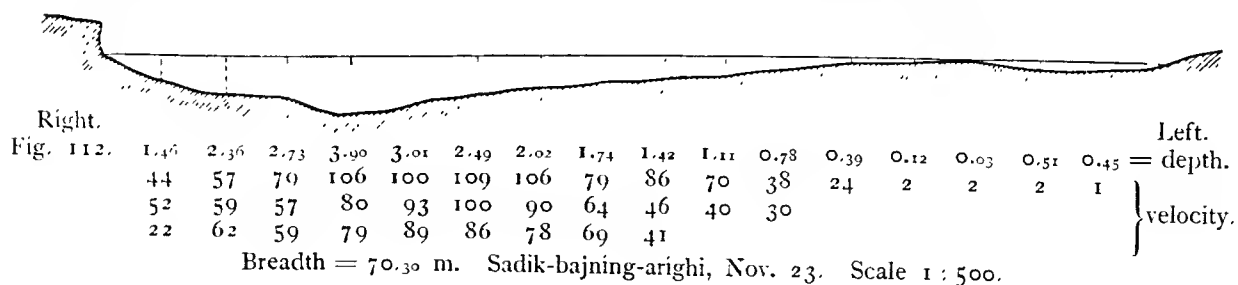


Fig. III. SURROUNDINGS OF THE CAMP OF NOV. 22.

Kara-akin-kojuschi through two channels, and contributes to it quite a respectable volume of water. After this the river broadens out a little, but still continues very shallow, and is quite swift. Just above our camp, situated in a spot that bears no name, the river widened out into a broad basin amongst the sand-dunes, and was for the most part filled with deposits of sand.

November 23rd. Rise, 0.15 cm. Transparency, 4.0 cm. at 7 a. m. and 5.1 at 1 p. m. Banks, 2.60 m. high; high-water level, 1.50 m. During the day the river swung away to the east-north-east, and became more sinuous. Just below our camp the sand suddenly came to an end, and receded altogether from the river, except in two places lower down. It was, further, hidden from us by a poplar wood, for these trees were now very plentiful again. Consequently drift-wood is once more common. The second arm of the southern parallel stream is called Kamber Schang-janing-jokarki-tötter-suji. Immediately below it there is an artificially dug canal, then

dry, called Kamber Schang-janing-jokarki-jangi-arighi, made for the purpose of irrigating some now deserted fields. The bottom of this canal was a good meter higher than the surface of the river. The Tarim is next joined from the left by an arm, which at the season of high flood, but then only, pours into it a portion of the water of the Kara-akin. On the same side of the Tarim lies an unnamed lake, with a connecting arm, through which there runs a current, sometimes inwards, sometimes outwards, according as the levels of river and lake vary with regard to one another. Here stand two or three deserted satmas. At Mus-asti, or rather Munghus-asti, or the Hung-up Antelope's Skull, on the left bank, an *atschal*, or »high-water branch», leaves the river, but rejoins it again a good bit lower down. Its upper end is narrow, though its lower end expands. At each extremity there is a sheet of water; otherwise it is dry, though in the high-water season it is said to swell to a very considerable stream. The high sand again touches the river at Sejt-uji, a hut abandoned some ten years ago by its former inhabitants, shepherds or hunters. The locality is what is known as *kona kopi* (= *gobi*) *jer*, i. e. »an old desert region»; in other words, it is waterless. Sadik-bajning-arighi is the name given to a canal which until three years ago, when it went out of use, was employed to irrigate some wheat-fields. Another canal, Muhamed Mirab-arighi, was likewise dry. All these canals issue from the right bank, a circumstance connected no doubt with the river's tendency to shift to the right, for the likelihood of their getting filled is then the stronger; possibly also the ground on that side lies lower. The water-courses which quit the river spontaneously on that side are in the lower-lying localities separated from it for considerable distances. On the left the Tarim is joined by an arm of the Kona-darja (Tunne-kis), while a second enters it at Arelisch, its termination being choked with silt. The name of Jar-jeghan-kum, which occurs here, is significant: it means, the Sand of the Eaten away Bank; and in point of fact, the river does just there encroach again upon the sand-dunes. To the north there is reported to be a considerable belt of sand. Places in which the dunes are eaten away by the river become quite common lower down, as we shall see subsequently. In the great majority of cases these places are situated on the right bank.



The subjoined measurements were taken at Sadik-bajning-arighi: breadth, 70.30 m.; mean depth, 1.442 m.; mean velocity, 0.6589 m.; and volume, 66.81 cub.m. in the second. It is noteworthy, that the river had only lost 3.3 cub.m. since the 18th Nov., especially when we bear in mind, that it is a newly formed channel it flows through, scarcely moistened to the normal depth, and is accompanied on both banks by a string of lakes. The explanation lies in what the natives had all along declared,



*Ljustr. A. B. Lagrelius & Westphal.*

TWO VIEWS OF THE RIGHT BANK OF THE JUMALAK-DARJA, CROSSING  
THE SANDY DESERT, NOV. 22ND.



that the river rises in autumn. Besides, these marginal lakes are practically so far cut off from the river, that they make scarce any perceptible drain upon it.

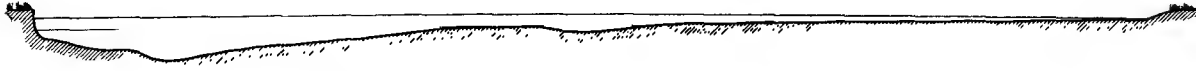


Fig. 113. THE SAME SECTION OF THE RIVER AT HIGH WATER. Scale 1:900.

Taking the heights of the high-water level as a guide, it is possible to make a provisional calculation of the total volume of the river at its latest maximum flood season. In the first place, let us confine ourselves to the body of water which lay above the actually existing current. Here the depth was, as the high-water levels indicate, everywhere 1.30 m.; and the breadth 70.30 m. But the velocity is of course not known; assuming, however, that its mean was 0.75 m., then we obtain, for the section of the river we are considering, a volume of 68.5 cub.m. Turning now to that part of the bed which was dry, — its breadth was 58 m., its mean depth 0.65 m., and its mean velocity perhaps 0.50 m. in the second; which gives a volume of 18.8 cub.m. This results in a total for the entire river of 154 cub.m. in the second at the period of maximum flood, a result which is rather under than over the mark, because it is quite safe to say that the velocity would really be greater than what I have assumed. At that period the volume must decrease very rapidly downwards from Jarkent, and both the Jarkent-darja and the Ak-su-darja carry an immense flood. In fact, on 8th June 1895 I measured in the Ak-su-darja and Toschkan-darja alone volumes of 306 and 169 cub.m. respectively, and in neither case had the stream swollen to its maximum dimensions. Yet we now find, that at Sadik-bajning-arighi the volume had actually dropped to 154 cub.m.; hence it is more likely to be 200 instead of 154 cub.m. Nor would it be an exaggeration to say, that barely one-fifth part of the water which flows past the point of confluence of the Ak-su-darja and the Jarkent-darja succeeds in getting down as far as Sadik-bajning-arighi. The reason of this is of course, that the river has to fill, as it goes along, the thousands of lakes and marshes which accompany it on either hand. In the autumn, however, when the second of the annual floods comes down the river, the circumstances are quite different from what they are in the summer. At the latter season large areas of the river-bed are dry, and considerable quantities of water are absorbed in daily moistening the bed itself, and the adjacent banks. In the autumn, however, all the channels are already moist, and all the marginal lakes and lagoons are already filled.

November 24th. Drop, 0.7 cm. Transparency, 4.5 cm. at 7 a. m., and 6.0 cm. at 1 p. m. Height of the banks, 2.70 m.; high-water level, 2.00 m. After describing an S-shaped loop, the river makes a curve to the east, and then traces a regular W, the points of which touch the sand on both sides. It was only at the extremities of the windings that we saw the sand, because of the luxuriant poplar woods which mask the banks. The tamarisks are perched on small solitary sand-hills, and the reeds grow along the margins of the river which is now persistently narrow, and the current tolerably swift. Just after passing on the left a locality called Tschong-töttöru, we came to a desiccated lake, Basäk-kätkän-köl, or the Lake of the Mown



Reeds, so called because its fresh reeds are cut to make fodder for the sheep. At the period of high flood, however, a small quantity of water does make its way into the lake. Here again we encountered Lop fishermen, who were just then particularly busy laying in a stock of fish for winter use. Over against the district of Kosch-kotan we discerned traces of a tiny *togh*, or »dam», in the mouth of a canal completely overgrown; its purpose was to prevent such water, as entered a lake on the inner or landward side of it at the high-water period, from finding its way back again into the river. Muhamed Kulluning-uji is the name given to a hut which ceased to be inhabited six years ago. After that comes the district of Kargh-jakti. In two or three places we observed dried fish-skins hanging on poles on the banks. These *nischan* or »notice-boards» are set up in particular at the entrances to the frozen *bulungs*, or »bays», that lie on the inner side of the alluvial peninsulas, and are intended to mark the fishing-grounds. Where one of these signs is put up, nobody has any right to fish except the man or men who in pursuance of ancient custom enjoy the privilege of fishing there. The river-bed still continued to be plentifully strewn with *kötäk*, or »drift-wood». In one place a poplar, which had been undermined, stretched out over the river for fully one-third of its breadth.

Meanwhile a noticeable change has come over the river ever since it emerged from the sand; it is now quite settled and steady as compared with the wild and unbridled torrent which races through the desert. The fact is, it is only the stretch between Kätschik and Mus-asti that is merely 4 years old; further down, below Mus-asti, the channel is 15 years old. Accordingly, in proportion as we advanced, after leaving the latter place, the local topography became increasingly wealthier in names. The natives of this district have observed, that during the past two years the river has carried a far smaller volume than it did previously, a circumstance which my Lajlik boatmen ascribed to the construction of the big Kandi-arik canal at Jarkent. But no one single canal could produce such a striking difference as that they indicated. Indeed there is nothing surprising in the river diminishing in volume for a couple of years; that is no more than might be expected from climatic variations, especially (in this case) a smaller precipitation amongst the mountains.

November 25th. Rise, 0.67 cm. Transparency, 6.6 cm. at 7 a. m. and 5.2 at 1 p. m. Banks, 1.65 m. high; high-water level, about the same. The temperature of the water, which was now approaching the freezing-point, decreased at a slower rate than heretofore. The natives maintained, that the colder the water the more rapidly it flows, and as an actual fact it would appear that, *ceteris paribus*, the current does possess the greatest power when at  $+4^{\circ}$  C. Here the sinuosities of the river are not very killing, the curves being short and abrupt. The river-bed still preserved the characteristics which it recently exhibited; the poplar woods were luxuriant, but came to an end towards the close of the day. We frequently touched the sand, especially on the left bank; but the dunes were clothed with vegetation, except in one place, where they were bare and barren. Here the river is known by yet another name, Chirki-darja, after a man who formerly dwelt on its bank. Over against Tajir-bajning-kotan is the large well-built, inhabited homestead of Ütsch-köl. Igis-uj, however, another homestead, founded 15 years ago, was abandoned after eleven years' occupation, its owner having betaken himself to Kutschar. Beside



LOW SAND-DUNES ON THE RIGHT BANK OF THE JUMALAK-DARJA, NOV. 22ND.



*Ljustr. A. B. Lagrelius & Westphal*

THE TARIM RIVER BELOW BUSRUGVAR, NOV. 28TH.

Thin Forest (Toghraks) on the Right Bank. The first Drift-ice showing on the River



it we found a couple of canoes, left there to maintain communication between the opposite banks. All the huts (*satma*) in this part of the country are constructed of faggots of reeds, affixed to a framework of posts and beams, just as they are in the land of Lop. There is not a clay or adobe house (*tam-uj*) to be seen anywhere. The highest dunes we observed during the day were at Jar-kum. Below this point an arm breaks away on the right for a short distance, and then re-enters the river again; still, such caprices are far less frequent on the part of this staid fifteen-year old stream than of the four-year old one. We now passed another inhabited homestead, Orosuning-uj; and then came to a miniature lake, Jantaklik-köl, nestling at the foot of the dunes. It owes its existence to a made canal, which, after filling it with water, is then dammed to prevent the fish escaping. Just below this, on the left bank, is a cemetery, here called *markat*, each grave being marked by a pole with streamers (*tugh*). Near the cemetery is an empty and deserted homestead, the inhabitants of which were carried off eight years ago by small-pox (*tschätschäk*), and were buried close by. At Arelisch-jasluk-utturghan there is yet another large deserted homestead; this, as the name indicates, is only occupied in the summer; its people, natives of Arelisch, spend the winter in their village (*mähallä*) there.



Fig. 114. LEFT BANK OF THE RIVER OPPOSITE TO TOKUS-KUM.

A day's journey south of our camp was the bed of the Opghan-darja, now perfectly dry and filled with sand, so much so that, I am told, there is not a single pool of water to be found in it. It enters the Tarim at Arelisch. Kamber Schang-ja, who acted as my guide at this stage of my journey, declared, that he

was born on the bank of the Opghan-darja, and that he was now 58 years of age. At the time of his birth this was the principal stream in the Tarim system, and the Lop-men dwelt on its banks. The country it flowed through was open, for the most part a kamisch steppe, with but few traces of forest. Nevertheless no small proportion of the annual discharge travelled along the bed of the Ögen-darja, which even then was a river of considerable size. Between these two streams lay disconnected patches of sand, the largest being Tokus-kum. When my informant was about 25 years old, that is to say about the year 1866, the river took the direction through the channel of the Atschik-darja, and, finally, in 1884 turned its waters into the existing bed. That is to say, this is true above Arelisch only, for between Arelisch and Karaul the river is said to have been constant to one channel for over sixty years.

To the north of our camp lay three streams; first, the Atschik-darja, which empties itself, at any rate partially, into the Tarim at Arelisch; beyond it the Ögen, which enters at Karaul; and farthest north the Tscha-jan, which probably discharges in part into the Kontsche-darja. The two first-named flow along deep, narrow beds, which, in the end of November, are dry in their upper courses, though a certain quantity of water is reported to be still flowing through their lower portions. In May and June the Atschik-darja is said to be completely dry; while in winter its water, except at its extreme lower end, is said to acquire a slight degree of salinity. At the period of high water, on the other hand, it swells to a really powerful stream. Its banks are in this part uninhabited. The great sandy desert only begins on the farther side of the Opghan-darja. Kamber Schang-ja asserted, further, that in his youth the region through which the Tarim now flows, at this stage of its course, was a barren desert.

This information points to the river having, for a long stretch, inclined to the left, contrary to what we have hitherto found to be the law governing its movements, at all events during the present generation. That law makes it keep shifting to the right; and, as we shall see subsequently, this law is generally applicable to the lowest part of the Tarim's course; moreover, its operation — subject of course to certain indispensable limits — has been secular. And even within

those limits it is probable, that there has been an oscillation extending over a very long period. In the part of the river where we are just now, the oscillatory period has been incomparably shorter. The predominant tendency of the river to shift there to the right may be a purely fortuitous circumstance. When it has reached the extreme limit of deviation towards the south, that is to the right, it would undoubtedly begin to return northwards again, that is towards the left; only here the period of oscillation is shorter. If we assume, as is reasonable, that the section of country,

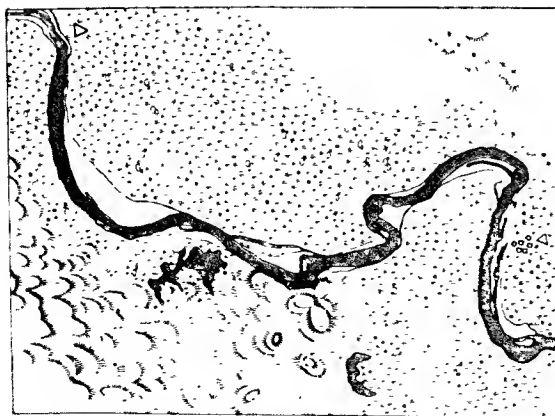
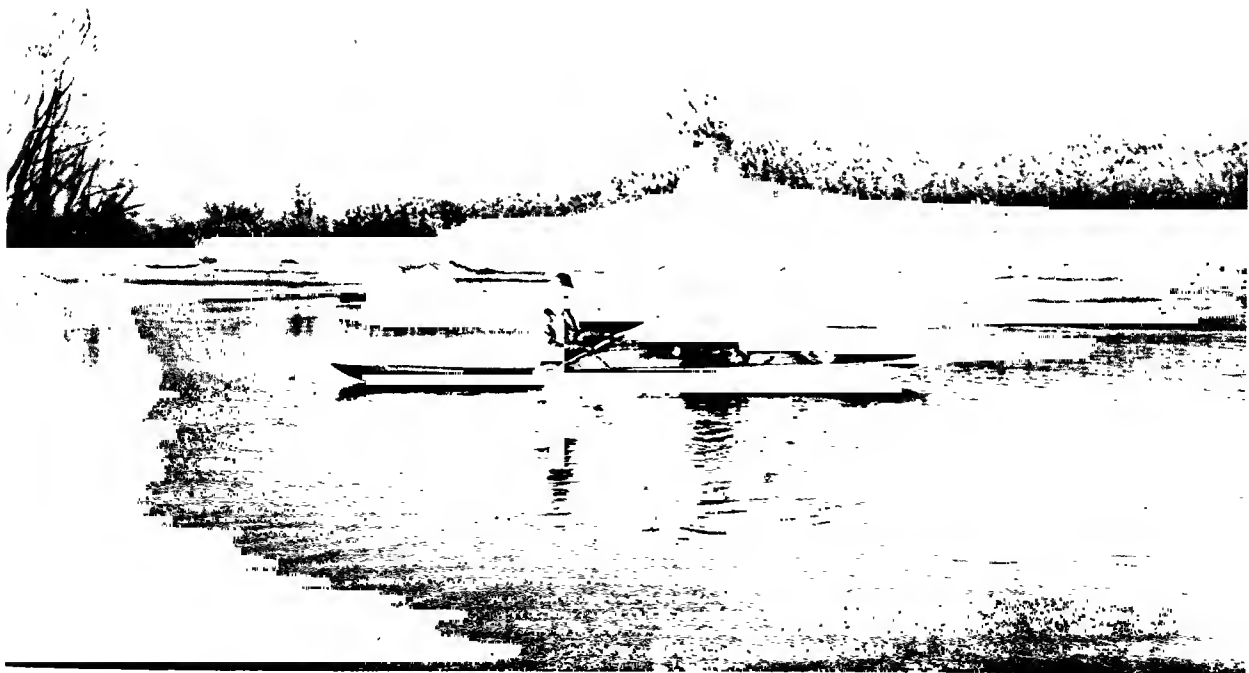


Fig. 115. TOKUS-KUM AND VILLAGE OF AL-KATIK-TSCHEKE.



THE JUMALAK-DARJA, NOV. 22ND.  
Dunes visible in the Background.



*Ljustr. A B Lagelius & Westphal.*

REEDS BETWEEN THE SAND AND THE RIVER, NOV. 22ND.



which is reached and covered by the periodical overflows of the Tarim, constitutes at each meridian a perfectly horizontal region, with an extremely gentle slope towards the east, there is nothing surprising in the water, and the channels which it follows, being alike extremely sensitive to even the very smallest changes of level. And such delicate variations are called into being by the river itself, partly through the sediment it deposits, partly through the belts of vegetation to which it gives rise. Those parts of the area of inundation, which at times fail to be reached by the water, dry up, and so become a comparatively easy prey to the winds. In this way the level is mechanically lowered by the transportation of the loose surface material; and whilst it is true, that the absolute change of level is *per se* insignificant, still the river is sufficiently sensitive to respond to even that slight alteration, and it does alter its course accordingly. These laws are operative on a much greater scale, and in a more conspicuous manner, in the lowermost reaches of the Tarim, and we shall therefore have an opportunity to study them more closely on a future page.

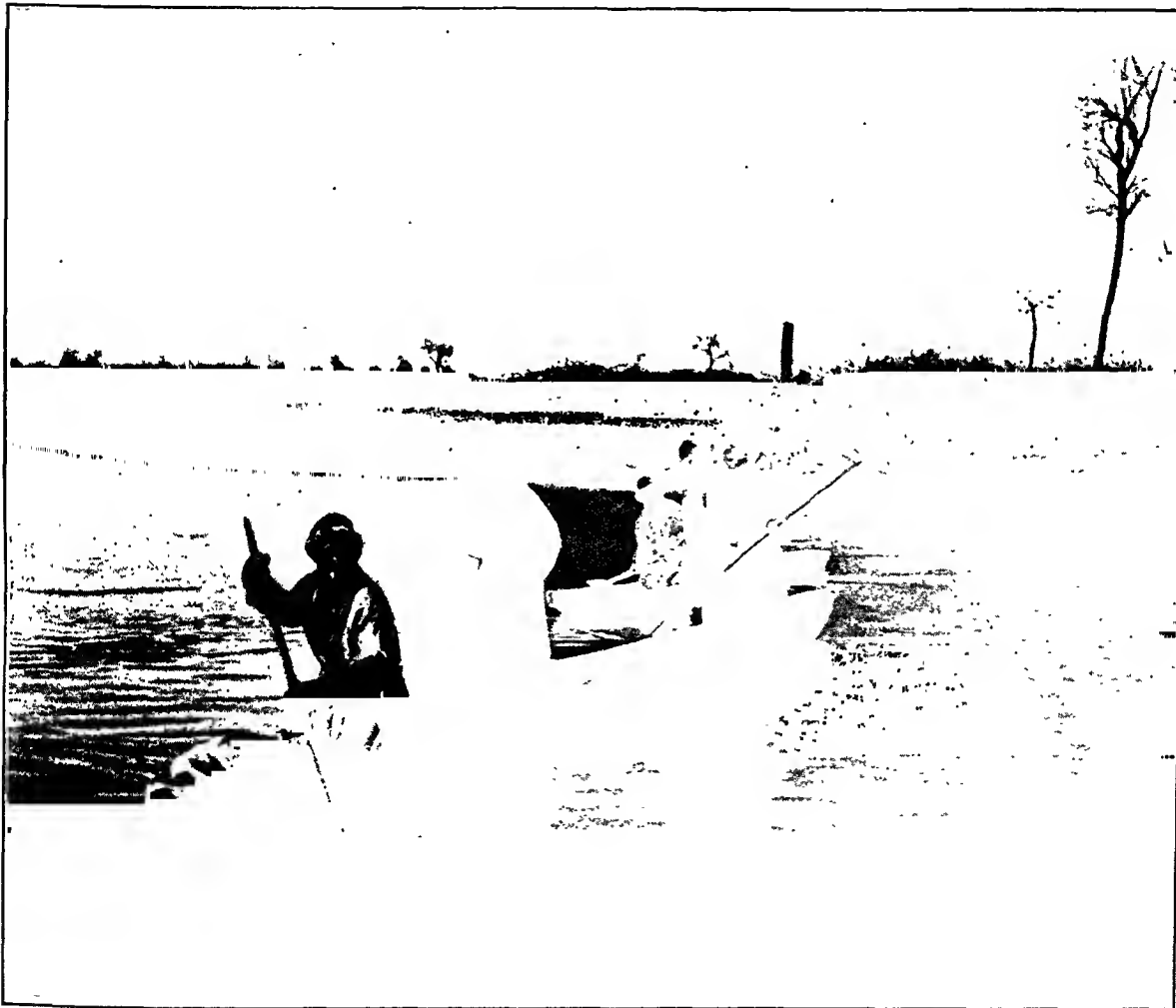


Fig. 116. ON THE TARIM A LITTLE ABOVE TOKUS-KUM.

*Hedin, Journey in Central Asia.*



November 26th. The level was unchanged; transparency, 8.8 cm. at 7 a. m. and 7.9 cm. at 1 p. m. Height of the banks, 1.9 m.; and high-water line, 1.5 m. During the day — it was a short journey — we passed the imposing dunes of Tokus-kum, or the Nine Sands. They consist of a gigantic accumulation of sand, culminating in an immense swelling crowned by several dominating crests; and the foot of the highest portion of the mass is washed by the river. The accompanying photographs will convey some idea of what that strange and peculiar landscape is like, a type of landscape which is probably without its parallel on the earth, and which could only originate where the actual conditions prevail, namely a powerful river flowing through or alongside of a desert studded with sand-dunes of colossal dimensions. But I must postpone the description of it to a special chapter, for we shall find that it is quite common beside the Tarim after this river turns to the south-east, that is to say, below Karaul, as well as developed there on a more stupendous scale.

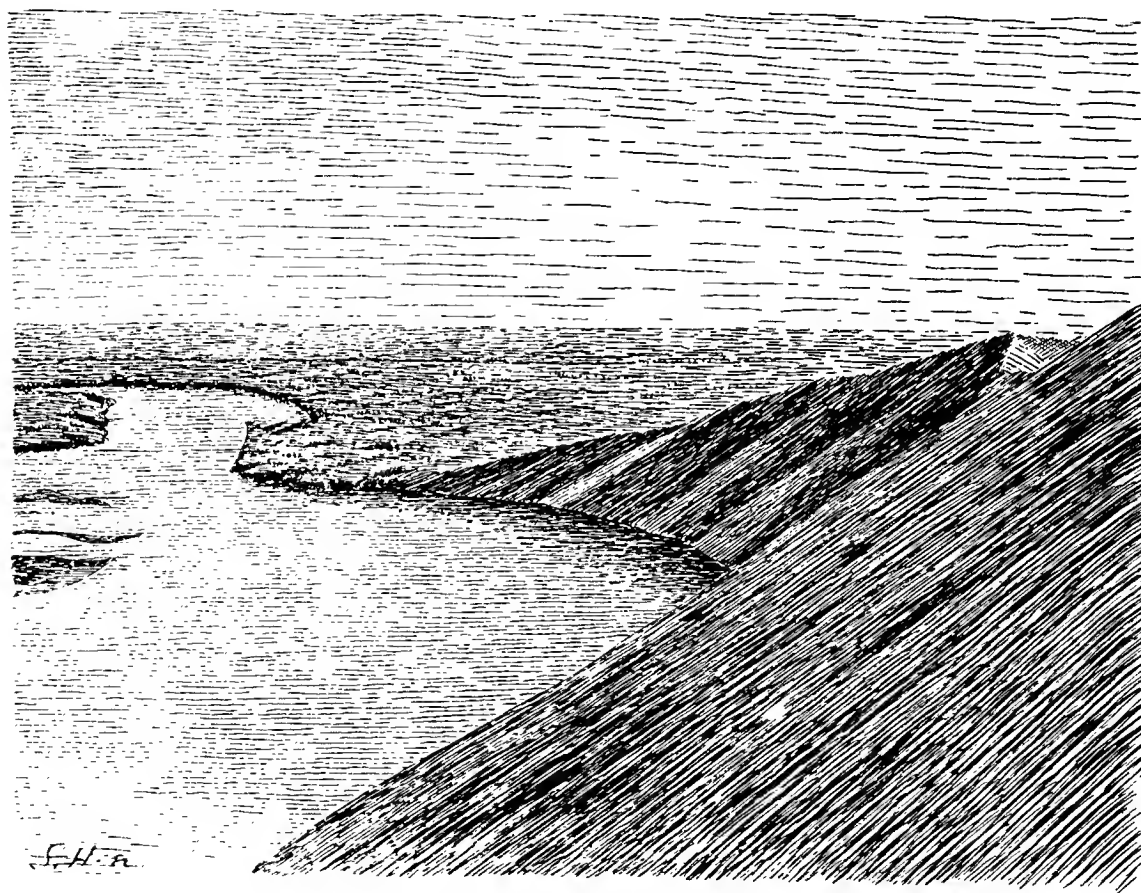


Fig. 117. THE EAST END OF THE SAND-ACCUMULATION AT TOKUS-KUM.

The Tokus-kum dunes that lie immediately adjacent to the river rise to an altitude of 51 m., and plunge down into the water at an angle of  $32^{\circ}$ . Now, seeing that the prevailing winds in this part of the country blow from the north-east, it may be stated at once, that it would be impossible for these dunes to have such an abrupt descent towards the north, did not the river incline to the right, and by



Fig. 118. NATIVES OF AL-KATIK-TSCHEKE.

means of its erosive energy undermine them to such an extent that they *must* descend at the steepest angle possible. But this question, too, we shall discuss lower down. The Tokus-kum dunes appear to be quite as large as those of the Saj-tagh, and in fact resemble a small mountain-range overhanging the river. On the east they terminate with extraordinary abruptness. The kamisch steppe, dotted over with poplars, advances to their very foot without any transition whatsoever, and without the smallest spur of sand penetrating amongst the trees. Now, seeing that these dunes are not held together by the roots of plants, but are absolutely barren, and consequently belong to the category of moving sand-dunes, it might be expected, that on their windward slopes, under the shelter of the woods, there would be a few patches of sand still surviving. But this is not the case. Hence the suggestion occurs, that the eastern foot of the Tokus-kum, like its northern, may at some time have been washed by the river, and, as a matter of fact, there does exist on that side a small crescentic pool, which may very well have formed part of a former loop, that has now disappeared. From the top of the Tokus-kum the only limit to the view was the haze on the distant horizon. To the south this gigantic accumulation of sand is connected with similar masses and patches of sand, all more or less detached and separated from one another by beds of kamisch. And beyond the Opghan-darja begins, as I have said, the continuous, unbroken expanse of the great sandy desert. Indeed, even to the north of the Tarim there is, for as far as we

were able to see, nothing but sand, though it is not heaped up to anything like the same degree that it is at Tokus-kum, and it is for the most part overgrown with vegetation. As compared with these stupendous masses of sand, the Tarim is like a mere narrow strip of meandering ribbon. There is a small lake even at the western foot of that part of the Tokus-kum which actually touches the river. And, as we shall find, the tendency for marginal lakes to be formed immediately at the foot of the highest accumulations of sand becomes still more pronounced as we advance down the river.

## CHAPTER IX.

### FROM THE TOKUS-KUM TO KARAUŁ.

The district below Tokus-kum is called Laj-su, and there, on the left bank, stands the village of Al-katik-tscheke, inhabited by ten families, or 35 people in all. Besides these, the bek, Istam Schang-ja, had under his authority twenty families in other villages in the vicinity. Another old man of ninety, who was born on the shore of the Kara-köl, had some sixty years before flitted up-stream, and finally come to anchor in Laj-su. The huts were arranged after the Lop fashion, in two compact masses, both to secure greater warmth in winter and greater shade and coolness in summer, as well as for more efficient protection against the storms. In addition they had stables for their cattle and sheepfolds for their sheep. The only trees at this village were five poplars. On a subsequent page will be found illustrations of typical Lop

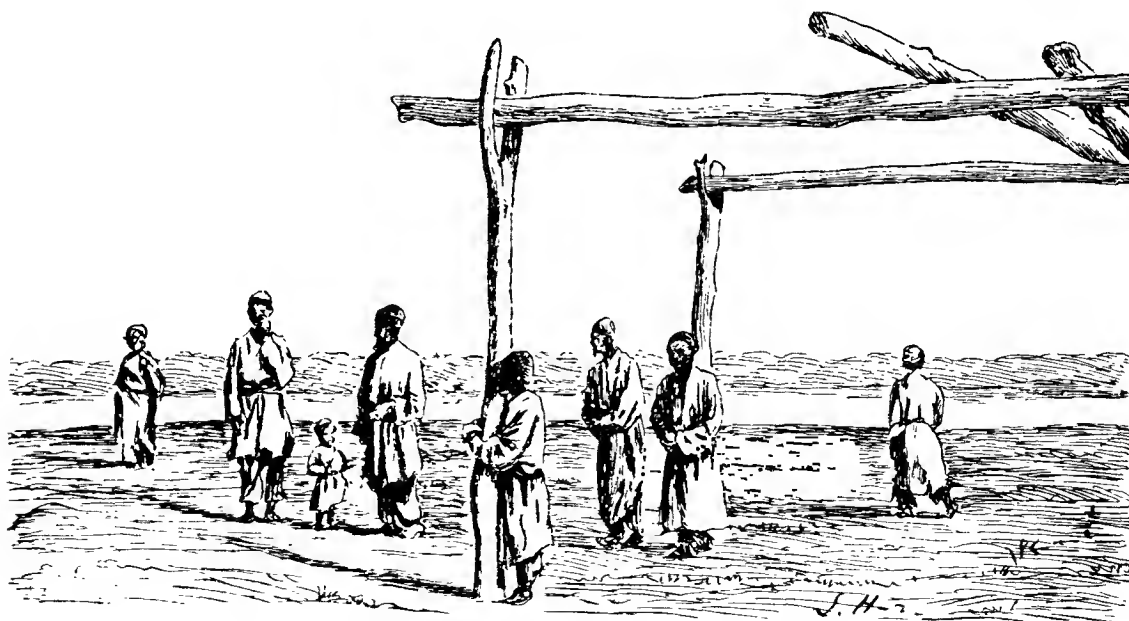


Fig. 119. HOW AN UJ OR SATMA IS CONSTRUCTED.



*Ljustr. A. B. Lagrelus & Westphal.*

THE VILLAGE OF AL-KATIK-TSCHEKE.





Fig. 120. THE UJ HALF FINISHED.

huts. Here I will simply repeat the native names for the different parts of the dwelling. The entire house is called *uj*; the vertical posts for the walls are *turkuk*; the horizontal beams against which the bundles of kamisch are fastened, *korsak*; *beldang*, the joists which support the roof; *baraj*, the spars which lie upon the last-named, and at right angles to them; *targhak-jaghatsch*, narrower joists lying parallel to the *beldangs*; *kalkan*, the beam which crowns the top of the wall and supports the joists; and *tungluk*, the square opening in the roof for the smoke to escape by. This constitutes the wooden framework or skeleton of the house. Against the sides of the framework sheaves of kamisch are set up on end and lashed fast to the spars, and others are placed on the flat roof, all in sufficient thickness to keep out wind and weather and keep in the warmth in winter. The fire-place, a hole in the ground, is called *ottschak*; arranged round it in a square are a number of wooden blocks, *päsch*, more than half of each block being sunk in the ground; these are intended to support and protect the felt carpets (*kighis*), which do not rest in direct contact with the ground, but upon kamisch mats (*pisat*) strewn underneath. The fire is fed with long thin billets of wood (*ottun*), which are gradually pushed across it as the ends burn away. Naturally the hut soon gets filled with smoke, which only gradually finds its way out through the *tungluk*, and both roof and walls are covered with a thick layer of soot. A round pole, *tschukutschäk*, is fixed near the wall, about  $1\frac{1}{2}$  m. above the ground, to hang clothes, rugs, and other articles on. The long, cylindrical pillows, or bolsters, are called *täkija* or *jasuk*. The name for a boat is *kemi*, for the paddle *kudschäk*, for a net *gölme*, or *gylme*. In a well-equipped house I likewise noted the following utensils, wares, etc. — *jung* = sheep's wool; *pustun* = pelts; *kiinlar* = garments; *urghak* = a reaping-hook, with which the kamisch is cut; *purutsch* = a wooden bottle for oil; *on* = flour; *tschöjtschuk* = a small

round sickle-shaped wooden dish; *tschömötsch* = a spoon; *kara-tschughun* = a copper kettle, in which the water is boiled for tea; *tängli* = a fish-trough; *sävät* = a withy basket for keeping wool in; *tavak* = a wooden dish out of which fish is eaten, as also mutton, after being cooked in a cooking-pot (*kasan*); *tobra* = a bag of coarse linen in which *talkan*, i. e. scorched and toasted flour, is preserved; *kavak* = a bottle made out of the rind of a pumpkin; *käpisch* = hard wooden slippers or sabots, intended to protect the *öttök*, or softer boots. A round, flat stone, with a hole in the middle (*ip-ghaschi*), through which a peg (*jighi*) is thrust, is a very common instrument throughout East Turkestan; it is used for winding the threads (*ip*) on, which the people twist out of their sheep's wool, the thread wrapping round and round the peg as the little instrument revolves. Further, I observed — *ghalvur* = a riddle; *paltu* = an axe; *kosar* = soft leather shoes; *kargha-jigde* = the berries of the *Eleagnus*, from which a kind of meal is made that is highly esteemed along the lower Tarim; *kak-salghan-balik* = fish split open and dried; and *balik* = the general name for fish just taken in a net. Fishing rather than sheep-breeding is the mainstay of these people of Laj-su; all the same, each household owned from



Fig. 121. A KAMISH-HUT FINISHED.

twenty to fifty sheep (*koj*), one or two cows (*kala*), and a horse (*at*). *Sojuk-asch* signifies a kind of soup, made of wheat meal dough, rolled out and cut into long strips, and then boiled in water. The people buy tea (*kok-tscha*), i. e. green tea, from the nearest town. In a minor degree they are dependent also upon the produce of the chase, especially antelope flesh. The tiger is only killed for the sake of its skin, which is especially sought after by the Chinese. The wild boar is of course never interfered with in a Muhamedan country. The gun is called *tufäng*, or *multuk*. Hares and small antelopes are hunted with falcons, which are

held in especial estimation all over East Turkestan, and frequently command high prices. Several of the Turkish words which I have quoted above are pronounced differently in other parts of the country. Still one may say that in general the dialectal differences are not particularly great.

Fishing is pursued partly in the small marginal lagoons (*köl*), after the ends of their connecting channels have been stopped up with poles, willows, and clods of earth, or else in the elongated bays (*bulung* or *körük*) which generally exist below every strip of alluvium. At Al-katik-tscheke fish are taken in the following way. After the bay or creek is covered with a sheet of ice 4 cm. thick, a canoe is driven against the edge of the ice, until only the stern is left hanging in the water, then the fisherman steps forward into the bow and by his own weight presses the canoe edge down, and so breaks the ice. Previous to this, however, a net is hung at the extreme edge of the frozen surface. After a channel has been thus broken about 10 m. wide, and the broken pieces of ice have been pushed with the paddles out into the river, a second net is let down at the new or inner end. The depth between the two nets (their positions are indicated at A and B on the subjoined cut) is not more than

1 m., and any fish that may chance to be between them are caught by drawing the two nets together. Meanwhile the fish, frightened by the noise of the breaking ice, have in all probability taken refuge at the inner extremity of the creek. A fresh channel is then broken through the ice, 10 m. broad as before, and the net is moved to the edge of the ice at A. In this way the nets are alternately moved higher up

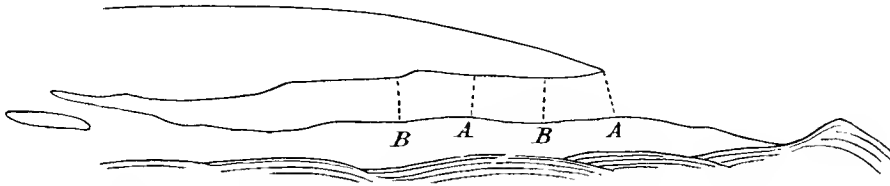


Fig. 122. THE POSITION OF THE FISHING-NETS IN A KÖRUK.

as the ice is broken, until there only remains the innermost extremity left, and it is there that the greatest haul is generally made. The net is kept vertical by means of sinkers or stones fastened to its lower edge, and by floats of sedge stalks (*jäkän*) tied to its upper edge. These latter also serve to show in which part of the net a fish has got entangled; thereupon the net is lifted with the paddle and the fish stunned by a blow on the head with a club.



Fig. 123. THE NET PLACED AT THE MOUTH OF THE KÖRUK.



At Al-katik-tscheke we obtained the following measurements: breadth of the river, 45.18 m.; mean depth, 2.094 m.; mean velocity, 0.7242 m.; and volume, 68.5 cub.m. in the second, consequently a not inconsiderable increase in the course of seventy-two hours. If now we make a calculation of the high flood volume in the same way as we did before, we obtain for the middle section of the river an additional volume of 55.5 cub.m., and for the two sections on each side of it 19.3 and 4.0 cub.m. respectively, or a total of 78.8 cub.m. more than the then existing volume, making a grand total of 147 cub. m. in the second. This, when compared with the former result (154 cub.m.), points to a truly insignificant diminution for high summer; but it probably represents pretty approximately the actual state of affairs, since it may indicate the precise point of time when all the marginal lagoons are filled with water, and thus no longer levy contribution upon the river; besides, the distance between the two points of measurement is not especially great.

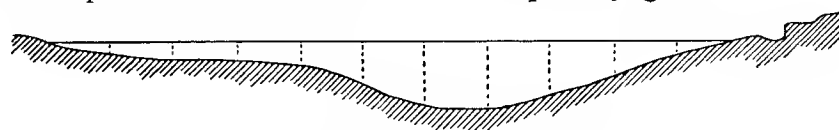


Fig. 124. Right. 0.84 1.17 1.25 1.68 2.80 4.20 4.47 3.60 2.22 0.80 = depth. Left.  
 59 73 91 93 103 100 90 50 46 35 } velocity.  
 29 42 58 92 106 101 103 67 53 33 }  
 25 22 69 92 88 99 75 50 }  
 Breadth = 45.18 m. Al-katik-tscheke, November 26. Scale 1 : 500.



Fig. 125. THE SAME SECTION OF THE RIVER AT HIGH-WATER STAND. Scale 1 : 900.

November 27th. Rise, 1 cm.; transparency, 7.3 cm. at 7 a. m. and 6.9 cm. at 1 p. m. The high-water level was 1.32 m., and the river-banks, which were uneven and sloped inland, were only very slightly higher. Except for two deep loops, the river here is not particularly winding. On the right the high sand is parted from the river merely by a belt of vegetation of varying breadth. The dunes are heaped up in lofty and imposing masses, resembling huge swellings or ridges (*āsar*), and separated from one another by patches of flat sand, hard and barren clay, or thin beds of kamisch. All the dunes are absolutely barren. The only spot in which the river here comes into contact with the high sand is opposite to the mouth of the Atschik-darja, where it just grazes past a patch on the right bank. On the left side of the river the dunes are farther distant, as well as lower, and covered with poplars, tamarisks, and kamisch. Poplars are now again quite common, and we had their forests with us all day long, although frequently interrupted by open steppes. On the left the Tarim is joined by the Atschik-darja, making with it an acute angle that points up-stream. Had it not been for the gentle current issuing out of the Atschik-darja, the confluence might have been taken for a bifurcation of the main stream. The current was however so very slight that, although the Atschik-darja at its embouchure was as wide as the Tarim, it did not augment the waters of the latter by more than  $\frac{1}{2}$  cub.m. in the second. At this time, too, the main stream



VIEW OF THE TOKUS-KUM, FROM THE LEFT BANK, LOOKING S.W



*Ljustr. A B Lagrelius & Westphal.*

VIEW OF THE SAME. FROM THE SAME POINT, LOOKING S.



was rising, whilst the Atschik-darja was unmistakably falling. It is very probable that the movement we observed was merely a movement of the superficial layer of water, and that there was a lower current from the Tarim forcing its way into the Atschik-darja along its bottom. After this confluence the only river remaining on the left hand is the Ögen-darja; except that there is said to be an old river-bed, deep, but now choked with vegetation, which has never contained water within the memory of man. The mouth of the Atschik-darja is called the Jokarki-arelisch.\*



Fig. 126. BREAKING THE ICE FOR PLACING THE NETS IN THE INTERIOR OF THE KÖRUK.

Immediately below this important point comes the Tömänki-arelisch, or confluence of the Opghan-darja, entering from the right. Although this river is so old, its terminal reaches are very exceptionally distinct and easy to see, and even contained an occasional frozen pool. The Opghan-darja, after breaking through the high sand at a point where dominating heights overhang it on both sides, strikes the Tarim at a slightly acute angle, pointing down-stream. Thus the Opghan-darja has at some time flowed along the outer margin of the great sandy desert in pretty much the same way, and under the same conditions, as the Jumalak-darja. In this

\* Properly speaking, the word *arelisch* signifies a »bifurcation», or »place of division, or parting», and is used when a river or a road divides, or when people, who have been keeping company, separate. *Koschlasch*, *kujluschi* or *küjüschi* is the word for »confluence». But in the country of the lower Tarim the words *arelisch*, *ajrilghan*, and *arghan* are used in both meanings, the consequence evidently of the natives' practice of traversing their waterways in canoes. Thus at Atschik-darja we have a waterway dividing into two branches, the direction of the current being ignored.

way the migrations of the river-bed impose from time to time a limit upon the extension of the desert sands, through their being thus to some extent swept away by the current. On the other hand, it is perfectly self-evident, that the close proximity of the drift-sand acts as a contributory factor to the river's vacillation, in so far as the winds carry its sand into the river-bed. This topic will, however, be discussed more fully later on. Certain it is, any way, that the portion of the Opghan-darja, which formerly travelled through the desert, is now buried underneath its sands. The dunes, whose onward movement was arrested by the advent of the Opghan-darja, have, like those which were stopped by the Jumalak-darja, on the removal of the obstacle, been able to continue their advance in one direction or the other. During the course of the thirty years which have passed since the Opghan-darja dried up, the sand has undoubtedly poured across its bed, at all events for long distances, in the same way as we shall find subsequently has been the case with the Ettek-tarim. It only requires the dunes on the one bank or the other to advance at the rate of two or three meters a year for the inevitable result to be produced. It is of course evident, that the dunes are older than the Opghan-darja, and that the river flung aside those which stood in its path. The next time the stream returns, in the future, to the channel of the Opghan-darja, it will have to do the same work all over again. It is indeed amazing that running water should possess such enormous force as to make headway against these overwhelming masses of sand. On the other hand stationary water is no more able to check the onward progress of the sand than the atmosphere is when at rest, so that the pools which probably remained at some time or other in the bed of the Opghan-darja have been powerless to arrest the resumed movement of the dunes.

After passing these two confluences we traversed a part of the Tarim which is very old, and which formerly served as the continuation of both the Atschik-darja and the Opghan-darja, just as this part itself now forms the continuation of the existing Tarim. Hence in that section the velocity diminishes, the river-bed broadens out, and becomes more deeply excavated. Above the two confluences the river-bed is still narrow, and the actual current occupied a broader section of it than the alluvial deposits did. As the map shows, the relation between the two naturally varies all the way down the Tarim. Where the river is narrow and deep, the alluvium necessarily finds little opportunity for forming deposits of any consequence; but where the river grows broad and shallow, there is ample room for it to do so, and in such reaches even an insignificant fall is sufficient to expose quite large expanses of alluvium. The work of erosion, which takes place in a river of the Tarim's character, is done, not at the bottom, but at the sides, and it is in this way that the innumerable loops are originated. So far indeed is the bottom of the river unaffected by erosion that it rather tends to rise, partly in consequence of the deposition of fine materials brought from higher up the stream, where the erosive energy is greater, partly from the caving in of the eroded banks, and partly from materials carried into the river by the wind. This circumstance, that the river-bed, instead of being gradually excavated, tends to rise in consequence of the river's own activity, combined with the influence of the accompanying vegetation, is precisely the cause of the Tarim's instability, whereby it is incessantly shifting its course bit by bit. The only places in which bottom erosion

does occur for a time are those in which the slope is more decided than usual, as, for instance, in the Kötäklik-darja, the Jangi-darja, and the Jumalak-darja; but even there its only object is to make the inclination uniform throughout, that is to say, no swifter than it is both above and below the new straight river-bed. But before this result can be accomplished, the erosion which attacks the sides of the stream has ample time to call into being the many serpentine loops which diversify the river's course. Meanwhile the bottom erosion, slight though it is, has already ceased, and the result it aimed at is accomplished simply and solely by the more appreciable effects of lateral erosion.

Just above our camp at Busrugvar, we found on the right bank a small marginal lagoon, with connecting channel, which is closed as soon as the high water begins to subside in the summer. After that the lagoon gradually shrinks in consequence of evaporation and absorption into the ground, and the water that remains behind becomes slightly brackish. This is considered to improve the flavour of the fish which are imprisoned in the lagoon, and which are caught as soon as the water has sufficiently subsided. And the same things apply to all the other small lagoons in this locality.

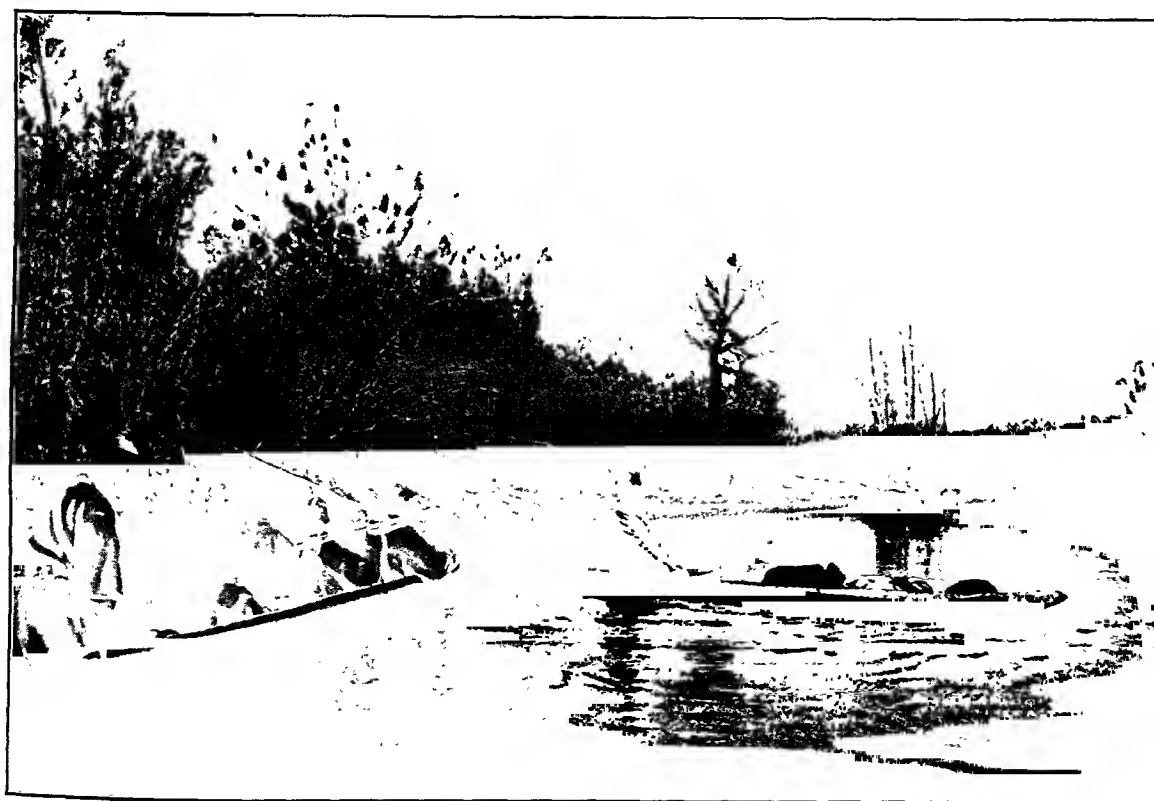


Fig. 127. RIVER-SCENERY ABOVE BUSRUGVAR, NOV. 27TH.

Above Busrugvar the river is split into several arms by the alluvial deposits. The men who acted as my guides in this locality told me, that two years before they had been employed to conduct a Chinese official, who was bringing some 30 or 40 canoe-loads of wheat from Saldam, to store them in the *sang*, or »granary»,

of Karaul, and they had led the flotilla two days down the Atschik-darja, which at that time (August) was full of water, and then reached their destination in five days more. But they had used their paddles, and consequently travelled a good deal faster than we did, for we were merely drifting with the current. My reason for citing this episode is to show, that the Chinese, who are practical and enterprising people, had also attempted to navigate the Tarim, and avail themselves of this natural waterway. Besides this, I heard of two or three other instances of similar attempts being made on Chinese initiative. But seeing how seldom the example has been followed, it would appear not to have been altogether satisfactory. In fact, the river is too distant from the towns and their agricultural centres, and also from the commercial highways, to be of much real advantage in this way. Add to this, the wearisome preparations which have to be made to procure a sufficient number of canoes, and their relatively small carrying capacity even when they are lashed together in pairs (*kosch-kemi*), with the view both of making them hold more and of steadying them. Under these circumstances it is cheaper to employ the ordinary means of caravan transport.

November 28th. Drop of 1.8 cm.; transparency, 7.8 cm. at 7 a. m. and 7.2 cm. at 1 p. m. Height of the banks, 1.38 m.; high-water level, 0.98 m. In this locality it was not expected that the river would rise any higher before it froze. The reason of this may be in part that the rise, which was occasioned by the return of the water from the ariks, had by this spent itself, and become less noticeable, and in part that the beginning of the frost was now imminent. In the evening the natives declared, that three days later the drift-ice, *kömul* or *kade*, would begin to show itself, and that it would last about ten days, and then the river would become definitively frozen over. However, as it turned out, they were wrong, for on the morning of the 28th the surface of the river was thickly strewn with soft drift-ice, especially in those parts of the stream which moved fastest, where it grated and rasped together. During the day, however, the drift-ice gradually disappeared, and by 1 p. m. was mostly gone, and entirely so by 4 p. m., when there was not a single patch left. Indeed, it would have vanished a good deal sooner, only it was a dull day, the sky being mantled with clouds. This *kade* is believed to frighten the fish out of the current into the *bulungs*, or still, bright bays, along the banks. Consequently, so long as the *kade* lasts, fishing is carried on there with the greatest eagerness: the people being anxious to complete their stock of fish for the winter so long as the opportunity lasts. Accordingly, that day we met several boating parties, especially from Arelisch.

During this day the river was unusually capricious. First it flowed due north-east as far as the Kötäktu-köruk, a little lake embedded amongst the sand-dunes, which, fed by a small channel from the river, is used as a fishing ground. Then it turns towards the west, until it reaches a patch of sand on the left; whereupon it finally wheels round, through a whole series of loops, to a direction north-north-east. The sand at the point where the river turns consists of barren and desolate dunes, connected with two formidable accumulations to the north-west, likewise destitute of vegetation. At their foot, next the stream, lies the lake of Tallik-tokajning-ajaghi-köl, a lake cut off from the river and containing brackish water, here called

*sej-su*, though in other districts known as *atschik-su*. Behind the two big massive dunes lies another lake, *Jäbir-köl*, which is only supplied through its canal at the season of high flood. The map would seem to suggest that it is the dunes of these two lakes that compel the river to alter its course. But this is not so; the contact between them is purely fortuitous, for when dunes come in the river's way, it simply sweeps them aside.

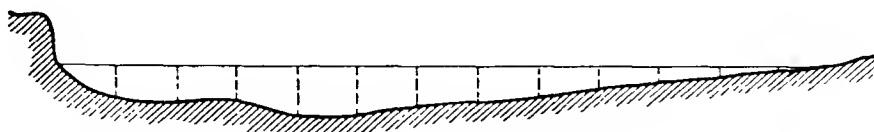


Fig. 128. Left. 2.16 2.69 2.44 3.26 3.30 2.87 2.46 2.10 1.72 1.22 0.85 0.66 = depth. Right.  
 50 77 87 80 74 78 80 73 79 70 54 43 } velocity.  
 59 68 82 75 71 75 80 75 68 56 40 31 }  
 59 68 81 83 75 76 80 68 60 45 }  
 Breadth = 51.2 m. Siva, Nov. 28. Scale 1 : 500.

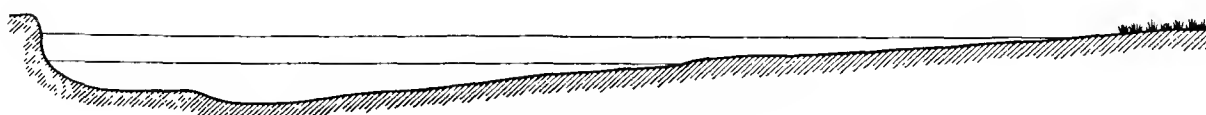


Fig. 129. THE SAME SECTION AT HIGH WATER. Scale 1 : 600.

At the base of the sand there is a loop to the left, most distinctly marked which was abandoned by the river the year before. On the right there are low dunes, with vegetation, in a locality called *Töttöru-jaghatsch*; and on the left the lake of *Sattovaldi-köl*, smothered amongst the reeds. The lake of *Laj-tscharti*, on the right, where a very successful fishing was then being carried on, was formerly much bigger, but, as the name indicates, it became partly filled with clay (*laʃ*) during some overflow of the river. Next comes, also on the right, a forest region, *Sägislik-tscheke*; opposite to it the forest is known as *Siva*. The locality in which we encamped was dotted all over with small sand-hills, and therefore bore the name of *Kum-tscheke*. Here, too, there was a marginal lake. Two or three of the little bays behind the alluvial deposits were covered with ice 5 cm. thick. All day the poplar woods were abundant in every direction, but at *Siva* they were especially dense and beautiful; in fact, the word *siva* means a wood of tall, slender poplars. At this spot the river measured 51.2 m. in breadth, 1.979 m. in average depth, 0.6633 m. in mean velocity, and had a volume of 67.22 cub.m. in the second. Thus in two days, notwithstanding the influx of the *Atschik-darja*, the river had lost  $1\frac{1}{3}$  cub.m. The height of the banks was here 3.36 m., and the high-water level was 2.18 m. above the existing level. An approximate estimate of the volume at the season of high summer gave 167 cub.m. in the second, or 20 cub.m. more than the measurement of 26th November. These 20 cub.m. — in reality it must be more — will indicate the volume of the *Atschik-darja* at high water. Here I was given the following particulars about the dry river-bed that lies to the north: its name is the *Kurugen-ögen* (the Dried-up *Ögen*); it lies three or four km. north-west of *Siva*; it ceased to carry water thirty years ago; it issues from the left bank of the *Atschik-darja* half



a day's journey above Orosaning-ujj, traverses a very sandy region, sparsely dotted with poplars, and finally enters the Tarim below Siva. The tract of country between the Tarim and the Kurugen-ögen is occupied on the south by poplar woods and on the north by sandy desert and steppe, and this conformation extends likewise across the last-named watercourse. The latter district is now entirely uninhabited.

November 29th. The fall was  $\pm 0$ ; the transparency, 7.2 cm. at 7 a. m. and 6.9 cm. at 1 p. m. The temperature of the surface water was now at the freezing-point, and it was only the movement of the current which kept it from freezing. From many different quarters we were told that, after the drift-ice had begun to appear, a single storm would suffice to bind the entire river in glacial fetters in the course of a single night; but if the weather remained calm, the drift-ice would continue to show for about ten days. All the bays and creeks and quiet reaches which were cut off from the stream were now sheeted with ice strong enough to bear a man, and every morning our ferry-boat and its attendant canoes were frozen fast, the ice being of the same strength as it was in the detached pools, and the craft had to be chopped out to get them free. Where the current was feeble, or there was none at all, a fringe of ice formed all along the banks, and every day these fringes grew thicker and broader, gradually contracting the belt of slowly moving water between them. A more or less thin belt of ice was by this formed round every alluvial deposit, as also round every piece of drift-wood that stuck up from the bottom of the river. All the moist parts of the channel, which were exposed, were frozen as hard as stone. In the morning the river was quite white with drift-ice. Through the action of an eddy close beside our camp the ice-disks were packed a foot high all along the edge of the ice in the bay where we were frozen in. At noon the stream was still half covered with drift-ice, and at 7 p. m. fully one-third of the quantity that there had been in the morning was still left, and at a late hour of the evening it had not all gone. Thus the river had taken one step more towards its winter lethargy, in that it now bore drift-ice throughout the twenty-four hours, while the drift-ice itself was increasing in thickness and in size. According to what the natives told me, the only things that could now banish it for say 48 hours or so would be bright sunny days and cloudy nights.

A closer examination of this *kömul* or *kade* showed, that it consists entirely of minute needles, flakes, and crystals of ice, all as thin as paper, and pressed together into compact masses, which glisten like new-fallen snow the moment they appear above the water, but when within it partake of its colour. The form they usually assume is that of disks, seldom more than one meter in diameter. The circular shape is imparted to them partly through rubbing against the banks, partly through natural friction when they come into sections of the current which move with unequal velocities. The same causes produce on the edge of each disk a flange or rim of soft, slushy ice, which turns snowy white the moment the water runs out of it. In consequence of this, the drifting disks look like wreaths of, say, immortelles floating on the surface of the river. Every time they jostle against the projections of the bank, or come into collision with other ice, a slight oscillation is set up in them, whilst at the same time the flange, at the point of impact,

grows a trifle higher and firmer. The surface inside the flange is perfectly smooth and bright, and gradually freezes together into a cake. During the warmer hours of the day a good deal of these soft ice-wreaths melts away, so that by evening there remains little more than the firm nucleus, though it too is softened; but then comes the night-frost and begins to consolidate it again. Thus each of these disks of ice acquires a certain depth, varying from one-half to two-thirds of its diameter. The bigger ones used often to get aground, even in places where our ferry-boat did not touch the bottom. Frequently, upon striking against pieces of drift-wood or getting into an eddy, they would split to pieces; but the pieces soon showed a decided tendency each to resume the regular rounded shape. Some of the larger disks had cracks across the middle, showing that they were composed of two or more smaller disks, which had come into collision with each other. The natives were all unanimous in declaring that this soft drift-ice is formed at the bottom of the river, and that during the coldest part of the night it rises and coagulates together into lumps. But the tiny ice crystals and laminae consist of perfectly pure ice; one would think that, if they were formed on the muddy bottom, they would be rather discoloured. Their characteristic shapes prove, on the other hand, that they are not fragments of the superficial ice which has congealed during the preceding night; indeed the current was still a hindrance to the formation of such ice. Possibly the seat of their origin is the stratum of water intermediate between the bottom of the river and its surface. The fact of these disks not being mixed with mud and sand is of course no proof that they cannot be formed at the bottom of the river; for, supposing they did contain such, they would be unable to rise to the surface until they had got rid of them. Upon poking the bottom of the river in the morning with a punting-pole, we found that it was as hard as a stone, just as though it actually were cased with ice. Later on in the day, however, it became soft, as it generally was; that is to say, the bottom ice had then been liberated and risen to the surface. As we lay anchored by the bank, we could easily observe how at sunrise the quantity of drift-ice on the river used suddenly to augment in quantity; meanwhile the grating, rustling sounds increased in intensity, and the drift-ice used to collide with the ferry-boat with greater force. That was the time of day when the blocks of ice were solider; but by midday they used to get so soft that it was easily possible to thrust a punting-pole right through them without altering their shape. A few of the disks remained hard all day, but these were formed in a different manner from the majority, in that their nucleus consisted of a compact sheet of ice which had become somewhere loosened from the river side, and then got adrift; yet the edges of even these harder disks were equally provided with the soft snow-white flange. The natives assert, that the drift-ice quickens the river's velocity; but this is not very likely. Theoretically, the drift-ice ought to move a trifle faster than the surface water, because the disks, owing to the depth of their immersion, are also carried along by those strata of the stream which are least retarded through the friction of the bottom or the friction of the atmosphere, although

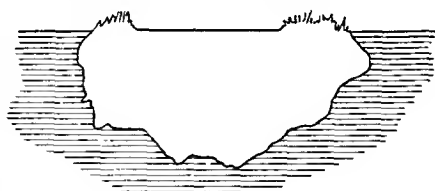


Fig. 130. VERTICAL SECTION OF A PIECE OF DRIFT-ICE.

the disks do lose momentum through coming into collision with the banks and the edges of the ice that lines them. On the other hand, this drift-ice is not especially sensitive to the wind, and for the same reason as before, namely that it is carried along by strata of the stream upon which the wind exercises no influence. Where the river was sinuous the movement of the ferry-boat was manifestly checked by the drift-ice. So long as the river was free from ice, our ferry-boat's weight and momentum used to carry her across the eddies and stagnant places; but it was precisely in these spots that the drift-ice was accumulated in the greatest quantity, so that our clumsy craft could not fail to be checked by them. The movements of the drift-ice made it much easier to study the relations of the surface current. The strips of running water and the eddies looked as if they were marbled or stained; and the drift-ice was most packed where the current was swiftest.

This day the river described two larger loops, to say nothing of minor sinuosities. Although the high sand marched quite close to us on the right, it only touched the river with two or three projecting tongues; between it and the stream stretched a belt of kamisch steppe, the »prairie» of Central Asia, with poplars, now completely denuded of leaves. Forest was quite general, and old, as would be expected beside this portion of the river, which has not shifted its channel for a very long time; yet it was only at the sharp turns, where the banks were high, that the trees approached close to the edge. The channel here presents pretty much the same character and appearance that it did below Lajlik: it is moderately broad, full of alluvial deposits and mud-banks, and is inclosed between high, steeply scarped banks, crowned by ancient forests.

On the right we passed the termination of an artificial canal, Töttöru, which in the summer supplies with water a lake lying behind the nearest high dunes. On the left are Rahmaning-köli and Rahmaning-kölning-ajaghi-köl, both entirely cut off from the river, even a connecting canal is wanting; hence their water is bitter. Then comes the Ördäk-jeghan-köl on the right and Iiasi-köli on the left. Next, near the right bank, is a patch of high, barren sand, called Ansasch-kum, after a *pavan*, or »hunter», who used it as a point of vantage whence to keep a look-out for game. I was assured that ten years before the wild camel had been seen at this the extreme outpost of the desert towards the north. Indeed, wild camel are said occasionally to visit the Opghan-darja, where they are hunted by the men of Schah-jar. Kamber Schang-ja declared, that in this district seven wild camels had fallen to his own gun alone. All the inhabitants of this part of the Tarim know well that wild camels do exist somewhere in the desert, and the statement made about its being at Ansasch-kum is all the more likely, because I myself in 1896 found the animal's tracks a long way to the north of the point where the Kerija-darja finally dies away in the sand.

A forest-tract on the right is called Sägis-tscheke. The dry bed of the Kurugen-ögen enters the Tarim from the left just above the place where we encamped. At the period of high flood, the water of the Tarim ascends it for a short distance, but as soon as the big river drops it flows back again. In the localities we had recently passed through small marginal lagoons were very numerous, and they still continued to be present for a good distance lower down. They possess one

peculiarity, in that they are served by only one canal, whereas the lagoons higher up are not only considerably larger, but each possesses both an inflow and an outflow channel. Several of them are also to a certain extent artificially made, for the channels which connect them with the river have been dug in places where the subsidence of the bank has left as it were a natural reservoir. The sole object of creating these artificial side-reservoirs is the fishing. Generally they bear the name of the man who dug the connecting channel, and who consequently enjoys the exclusive right of fishing in them. And where we have one of these lagoons not named after a man, as for instance, the Kötäktu-köruk, it may be assumed that it owes its existence to a natural overflow.

November 30th. Drop  $\pm 0$ ; transparency, 7.0 cm. at 7 a. m. and 7.0 cm. at 1 p. m. The high-water level ran 1.35 m. above the existing level. There was to-day less drift-ice than usual on the river, owing to the minimum temperature being more than ordinarily high; in fact, the surface was barely half covered with ice, and notwithstanding that the sky was clouded, the greater part of what there was disappeared during the course of the day. The air was still and mild. By evening the few pieces of drift-ice that still remained were both soft and small. Thus, with regard to its winter panoply of ice, the river rather retrograded than advanced.

The Tarim then became unusually straight, making only one or two sharp turns towards the close of the day's journey. The high sand kept us faithful company on the right, at a greater or less distance away, but always visible as a lofty swelling of a yellow colour. In fact, it forms such a conspicuous and all-dominating feature of the landscape as to suggest a mountain chain of northern Tibet, and it exhibits the same rounded and denuded outlines. It is said to stretch uninterruptedly towards the south across the whole expanse of the desert; which indeed is quite likely, for there is nothing to suggest that the sand in the heart of the desert is not unbroken. Towards the close of the day, however, a bend in the river brought us once more close in to the base of the sand at the only spot where it bore a few poplars. We had never been so near it since we left Tokus-kum. The accumulations of sand-dunes attained altitudes of 60 to 90 m. Along the left bank, too, there ran chains of sand-dunes, but they were very much lower in altitude, and while some of them were absolutely barren, others were scantily clothed with vegetation. A day's journey to the north lies the bed of the Ögen or Ugen-darja, with its accompanying belt of forest. Otherwise the country between the two is entirely occupied with low dunes and with what the natives call *tättir* or *töttör*, that is to say sandy soil destitute of water, though bearing tree-stumps and other traces of dead vegetation.

At Ak-daschi there is a break, a gap or valley, through the sand-dunes on the right, the bottom of which is stated to be level and free from sand. This, too, is believed to be the last surviving section of an ancient river-bed, of which no other traces are known. The bare soil between the dunes supports some scanty scrub. Then follow in succession — on the left the densely wooded tract of Jam-alghan; on the right Sägislik-tscheke and Jurgelik-tscheke; on the left the little fishing-lake of Rahmaning-körughi, Örmät-öldi, with three small lakes, and Mülken-

äger-köl, without any visible connecting channel; and on the right an unnamed lake, now cut off from the river, and Bos-ökte. The two last lakes are also without any visible connection with the Tarim; possibly they draw upon some subterranean supply. Here the river makes a sharp bend, the neck of land at the base of the bend being so narrow that at the next high flood it must infallibly be cut through. The place where we encamped was called Ait-öttögön. During the last two or three days of the journey we had observed remarkably few people on the river-banks; in fact, we had seen no natives since leaving Laj-su, although we had on a few occasions observed their huts and *saldams*, that is to say, cubical arrangements of poles on which the antelope hunters place their »bag» for protection, though the only game that we noticed, and that at intervals, were pheasants, hawks and ravens.

December 1st. The drop was  $\pm 0$ ; the transparency, 7.0 cm. at 7 a. m. and 6.8 cm. at 1 p. m.; the height of the banks 1.45 m.; the high-water line 1.20 m. The river travels by wide windings towards the north-east. The high sand still keeps us company as before, though sometimes, when the river bends away from it, it becomes hidden behind the forest, which consists here of poplars of a venerable age. At the second of the day's loops the river grazed a high dune, the top of which afforded a wide and commanding view of the adjacent country. The loop was full of sedimentary deposits, and the frozen stagnant water between them, being bright and blue, contrasted sharply with the grey, muddy water of the moving stream. The ice was now a decimeter thick. To the south-east there exists nothing but high sand, absolutely destitute of vegetation — an »ocean» of dunes as far as we were able to see. To the north-west there is low sand as heretofore. The zone of vegetation which accompanies the river is at the most two to three kilometers broad, seldom more, unless we add the scattered tamarisks which manage to subsist amongst the sand; in fact, it appeared to be in a transitional state, verging on extinction. Along the base of the high dunes next the river there is generally a zone of poplars. Dunes which actually impinge upon the river are called by the natives *jar-dung*, or »bank-hill». To-day, again, the drift-ice was not especially plentiful, though it managed in a fashion to persist until the evening. Upon reaching Jigde-söre we were half-way between Laj-su and Karaul, Jigde-söre being on the boundary between the two districts. Here the northern sand touches the left bank of the river, though, as usual, it does so only at the bends. On the right bank is the little lake of Jigde-sörening-köli. Neither our camp nor a saline lake in its vicinity bore any name. The country still continued to be uninhabited, without the least signs of human presence. Names are fewer, too, upon the banks. Those that do exist are the names of *mänsil*, or »stations», marking the places where it pays to fish.

December 2nd. Rise = 0.3 cm. in 14 hours; transparency, 8.0 cm. at 7 a. m. and 9.5 cm. at 1 p. m. Thus during the past few days the river had cleared a little. This was probably due to the banks having frozen down to the water-line, so that the landslips and landslides had now ceased, whilst at the same time the thick fringe of ice checked the erosive action of the surface current. That the river did not clear at a more rapid rate was no doubt due to the great velocity of the stream; in part



*Lystr. A. B. Lagrelius & Westphal.*

VIEW LOOKING W.N.W. FROM THE SECOND LOOP IN THE SAND, DEC. 1ST.



also, I dare say, to bottom ice rising to the surface and stirring up the mud. The banks were here 1.42 m. high and the high-flood level 0.94 m. The drop in these two data was due to the river having broadened out; in this respect it resembled the reaches below Lajlik. The banks were planted with forest. The river-bed contained extensive deposits of mud, separated by more or less considerable arms of the stream, the larger of these being open, as we indeed perceived some distance before we reached them from the movements of the white drift-ice, whereas the narrower arms were frozen over. The natives have observed, that the muddy water freezes more easily and earlier than the bright water, other conditions being of course equal. The river flowed unusually straight, especially during the second half of the day. The only living creatures we saw were ravens, though on the banks the tracks of antelopes, roe-deer, red-deer, hares, foxes, and wild-boar were reported. The sand retreated somewhat, and during the latter part of the stage was out of sight. At Kischlak-uj there is a loop abandoned by the river five years ago, and now containing a reed-grown lake, which was frozen. Then we came to two small fishing lakes, Karaunelik-köl and Kutuschtu-arighi; the latter, which is divided into two basins, derives its name from its owner. Farther on, on the same side of the river, is Jaka-köl surrounded, like the preceding, by sand-hills bearing poplars. Towards the north-west it is now 3 or 4 km. to the Ugen-darja. The zone of sand which hitherto has extended between the two rivers has gradually thinned out and now ceased, or at least dwindled away to a few scattered dunes, low in elevation and covered with vegetation. Apart from this, the belts of vegetation which accompany the two rivers are here continuous, forming a single forest. On the right lies the sandy district of Tataktik-kir, and on the left the forest tract of Kondak-alghutsch and the lake of Ilekköl.

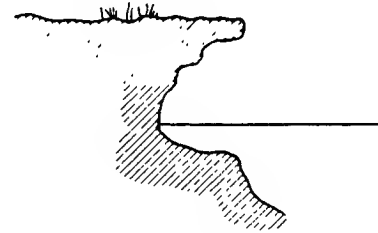


Fig. 131.

December 3rd. Transparency, 9.5 cm. at 7 a. m. and 7.6 cm. at 1 p. m. Height of banks, 1.35 m.; high-water level, 0.84 m. The ferry-boat, which lay all night beside a perpendicular bank of the height indicated, gave rise to a whirlpool, which gradually excavated a kind of cave (fig. 131) in the sandy bank. The ground, being frozen to the depth of 2 dm., consequently hung suspended above the river like a vault, and was strong enough to bear a man upon it. In the morning the river was three-parts covered with drift-ice. The quantity, or rather the concentration, of the drift-ice was a constantly changing factor, varying inversely as the breadth of the river. Where the latter is narrow, the whole of its surface becomes filled with glistening moving ice, but when it widens out, the ice separates and becomes more scattered. In the loops the ice packs and piles itself up into miniature *torosses* or »hummocks»; but under normal conditions the glittering white string of ice-disks moves quietly and steadily down with the stream, and seems to some extent to assist the drift of the ferry-boat, for when packed about by it, she did not appear to be influenced by the wind. In the narrow reaches, where the drift-ice grinds together and rubs against the banks, it produces a rustling, sawing sound; in the broader parts of the river it flows on the contrary more silently. Upon getting caught in an eddy or thrust aside into dead water, the disks come to



a standstill; but soon the space grows too crowded, and some of them are again thrust out into the current, and so continue their journey down the river, until they once more lodge against some obstacle or other. The river is now finally frozen for the winter in the spaces between the mud islands, all round the margins of the alluvial deposits, and over the shallow places, where there is a slight current or none at all; and consequently, where the river is broad, one sees large expanses of ice, as bright as glass, reflecting with extraordinary vividness the objects in their neighbourhood. On between these bright ice-sheets moves unrestingly the white chain of ice-disks, contrasting in a striking way, both by their colour and their movement, against the fixed ice-belts that fringe the banks. These latter keep encroaching more and more upon the strip of open water in the middle of the river. My guides gave the stream another six or seven days before it should be completely frozen over; but they declared with emphatic conviction that even then, if a storm were to arise, it would be set fast from end to end in a single night.

During the first half of the day's journey the river was tolerably winding, but during the second half unusually straight. It was very broad, especially at the points of some of the windings, where it swung out so far as to leave veritable small lakes, now however filled for the most part with alluvial deposits. And as the banks were here lower than usual, we had a most extensive view on both sides of us. Looking northwards we perceived, on the other side of the thin forest which grew nearest to us, the thicker woods of the Ugen-darja; while to the south the yellow masses of sand glinted through the stems of the poplars. But the edges of the banks next the river were all along lined with thick beds of reeds. During the latter part of the stage, while the river was flowing towards the north-east, the sand once more receded out of sight. On the north there were now left only an occasional solitary sand-dune and mounds overgrown with tamarisks.

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*Illustr. A. B. Lagrelus & Westphal.*

THE FERRY-BOAT IN THE MOUTH OF THE UGEN-DARJA, AT KARAU. THE TARIM ON THE RIGHT.



## CHAPTER X.

### THE HYDROGRAPHIC RELATIONS OF THE UGEN-DARJA AND THE TARIM.

The Ugen-darja was now rapidly approaching. Due north of our camp at Ileik there was a place on its bank called Daschi, inhabited by 6 Loplik families; but between that place and Karaul there were reported to be only two shepherds and their families still dwelling beside the Ugen-darja. The immediate vicinity of the main river is, as we have seen, wholly uninhabited all the way from Laj-su to Karaul, except for an occasional shepherd, who may flit over with his flock for a time from the Ugen; for the pasture beside the Ugen-darja is considered to be better than that beside the Tarim in this part of its course. The former stream was said to be frozen over, though the ice was still thin, and not strong enough to bear a man. Thus the Ugen-darja freezes later than the Tarim, a fact which is due to several circumstances: it is better protected by its thicker forests, it is narrow and deep, and its water is always clear and still. The same circumstances also cause its ice to break up in the spring later than that of the Tarim.

A big bend which the latter river makes at Abbas-kötörmesu, below the forest tract of Jarghutschak-kumdi, approaches very near to a southern loop of the Ugen-darja, the distance between the two being, I am certain, not more than one or two hundred meters. We have an evidence of the fact in the first of these names, for *kötörmesu*\* means »portage», or the place between two rivers where a canoe can be dragged across from the one to the other, *i. e.*, the narrow neck of land at the base of the loop. Just below this is the double lake of Daschi-köl, which, besides being connected with the Tarim by a channel now dry, derives part of its water also from the Ugen-darja; in fact, it is said to lie nearer to this latter river than to the Tarim. Here the left bank is called Kala-askan, or the »Hung-up Skull», a name that we find under one form or another in various parts of East Turkestan. The next south-going loop makes a serious attack upon the base of the high sand. At the time we saw it, the inner end of the loop, next the dunes, was filled with deposits of sand, and the channels of water which ran in amongst them were frozen. At these points, where the river touches the outermost margin of the sandy desert, changes, even though not of

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\* From *kötörmak* = to fetch, to drag.

a drastic character, take place every year. Early in the spring, before the ice has begun to break up, the storms from the east and north-east blow the dunes over on to the ice; though it may be to no serious extent, still blow them they do. At last the ice breaks; then there is a sand-slip down the dune side. Later, when the ice has melted, and the current has grown powerful enough, the sand which lies in its path is swept down into the bed of the river. But this sand, be it remembered, only a few days, or it may be a few weeks, earlier formed the basis or support of the towering mountain of sand which now hangs threateningly above it. Here, then, sand-slides of some magnitude continue to take place, and as they fall, they are swept away one after the other by the stream. In other words, in these spots there is an incessant struggle going on between river and drift-sand. The latter, however, because of its merely passive power of resistance, is doomed to succumb to the aggressive and incessantly active agency of erosion.

On the left bank I have to record finally the two names of Avul Ali Bek-kätgän-uj and Momuni-ottogho, and on the right Avul Eselning-uji and Karghasi-asti. This region is said to have been inhabited about seventy years ago, a fact which is also clearly witnessed to by the names, which tradition preserves long after their owners have died and been forgotten. From Momuni-ottogho we obtained our

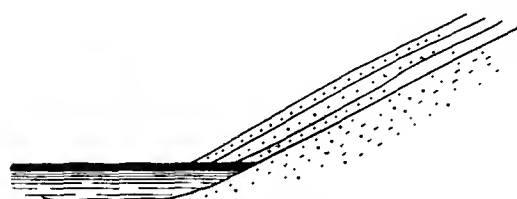


Fig. 132. SAND BLOWN DOWN UPON THE ICE OF THE RIVER.

first glimpse of the Kuruk-tagh, faintly discernible in the north-east, at a distance of 45 km. Thus in winter the atmosphere is not so especially clear, at any rate when compared with the clear atmosphere of Tibet, where it is possible to see mountains at three times that distance. In summer it would be very rarely, if indeed it would be at all, possible to perceive the Kuruk-tagh at a

distance of 45 km. The prevailing wind in this part of the Tarim basin comes from the east. With regard to the river's characteristics, I was told that it begins to rise in the beginning of August; the high water reaches its maximum in the end of September or beginning of October; from the beginning of November it subsides rapidly day by day, until it reaches the level at which we found it and which it maintains until the river freezes. In this part therefore no secondary rise has been observed just before the winter ice sets in; whence we must conclude, that the rise which does occur higher up, when the surplus water from the irrigation canals finds its way back into the stream, is neutralised by the distance, and is no longer effective here. That there is no overflow water to find its way back into the river in *this* locality is perfectly evident. In the first place, there are no cultivated tracts in the neighbourhood; and in the second place, the Intschkä-darja and the Ugen-darja, both lying to the north of the Tarim, would inevitably intercept any spring water that might chance to travel so far down out of the mountains. But after the Tarim freezes at Momuni-ottogho and Karaul, the stream rises underneath the ice, lifting it bodily, or in some places the water, rising through cracks in the ice, flows out over it. This rise is said to be occasioned by the masses of drift-ice getting packed together in narrow places, and so acting like a stopper, in consequence of which the level rises up-stream. And then of course, when the hindrance is removed, the

water subsides again. The river remains frozen for three months, or if we take into account the soft and rotten ice of early spring, for three and a half months. The melting of the ice occasions here, as everywhere else throughout the basin of the Tarim, an early spring flood; but after that has passed, the river continues to drop until it reaches its lowest ebb in June. Here I was told that, whilst the Tscha-jan does indeed empty itself into the Tschong-köl and a series of small lakes, yet for the last 15 years it has failed to effect a junction with the Kontsche-darja.

December 4th. A rise of 1.1 cm.; transparency, 7.4 cm. at 7 a. m. and 7.9 cm. at 1 p. m. Height of the banks, 1.92 m.; high-water level, 0.65 m. During this stage the river was straighter than ever, and the velocity considerable. Just below Momuni-ottogho the river widens out over an enormous expanse; its numerous arms, winding amongst the sedimentary deposits, give it the appearance of a delta. The high sand recedes to a comparatively great distance, and was only seen on two or three occasions. Forest is plentiful all the way to Karaul; but at Karaul kamisch steppe, tamarisks, and small conical hills are the predominant features, the poplars being confined to a few individual trees standing some distance back from the river. Here we did not see a single human being. The drift-ice appeared less abundant than usual, though it was in appearance only, for the river was here wider.

At Attamet-arghaj (Attamet's grave) there is said to be a tomb, surrounded by a wooden fence, still preserved from olden times. Other names of the local topography are — Aral-kum, the Island Sand, small dunes, with vegetation on them, situated like islands amongst the poplar forest; Karaul-dung, a dominating sand-dune on the right bank; then, lower down on the same side, Basch-tam, with an artificial canal leading to a wheat-field. Here it was we first found human beings again, namely, two families. There too the river turns and flows due north. On the left, that is on the angle between the Tarim and the Ugen-darja, we passed an isolated patch of low sand-dunes, bearing vegetation, and with a couple of small lakes nestling against their southern foot. The Ugen-darja, just before entering the Tarim, describes a loop to the south-east, south, and north-east, and in that direction effects its confluence with the Tarim, when the latter is flowing northwards. Shortly after that the Tarim inclines to the east and east-south-east. Here then at Karaul we have one of the most important points in its hydrographical system, namely the point where, after its long course towards the east, it turns to the south-east, and so travels to its terminal lakes. The little village of Karaul, consisting of 4 huts, stands on the right bank of the Ugen-darja, a short distance above the

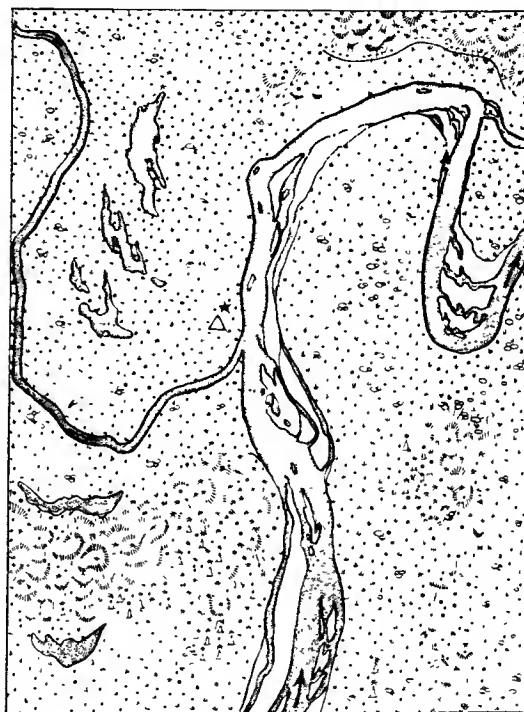


Fig. 133. THE CONFLUENCE OF THE UGEN-DARJA WITH THE TARIM AT KARAU.

confluence. Below the left bank of the Tarim, as it were on a peninsula between the two rivers, lie a number of small lakes. The country here is quite open.

The water of the Ugen-darja was transparent to a depth of 69 cm.; that of the Schah-jar-darja was transparent down to 78 cm. The reason for the difference is that the former river had a gentle current, whereas the latter was stationary. The bright, blue-green water of the Ugen-darja makes a strong contrast against the turbid current of the Tarim, and the difference is still distinguishable 300 m. below the first point of contact. The brighter water of the Ugen-darja gradually contracts under the left bank of the Tarim, until it finally dies away. At Karaul the Ugen-darja was frozen over, though the ice was so thin it would not bear the weight of a man. At its mouth the only ice consisted of thin, narrow strips fringing the banks.

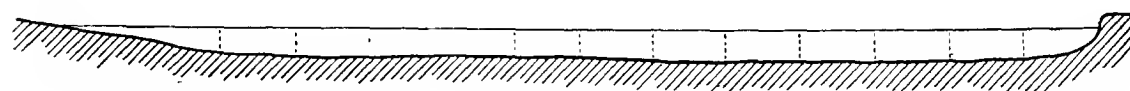


Fig. 134. Right. 0.42 1.31 1.42 1.47 1.52 1.48 1.53 1.59 1.63 1.64 1.69 1.73 = depth. Left.  
 28 72 82 71 82 81 83 92 90 92 96 68  
 23 28 63 59 52 64 61 70 85 72 69 70 } velocity. \*  
 54

Breadth = 54.9 m. Karaul, Dec. 5. Scale 1:400.

Just above the confluence the width of the Tarim was 54.9 m.; its mean depth, 1.362 m.; mean velocity, 0.74 m.; and volume, 55.33 cub.m. in the second. Hence, since 28th November, it had lost 11.9 cub.m., an unexpectedly large quantity when we remember the shortness of the distance and the fact that no side-arms here break away from the river. I have no doubt, however, that the level oscillates just about the time the river freezes. Each part or section of the river is dependent upon the sections which lie above it, and any oscillations that take place in them must in some way or other make themselves felt throughout the whole of the river's lower course. If we imagine the higher sections to be subjected to a more than usually severe frost, then the sections lower down become deprived of a portion of the water which would in the ordinary course of things have come down to augment their volume. It is just this circumstance, of enormous quantities of water becoming ice-bound in the river, which occasions the first spring freshets when the great thaw takes place. Every effect must have its cause! Thus the spring flood is simply the retarded flow of autumn, which has been detained in the ban of the frost during the winter.

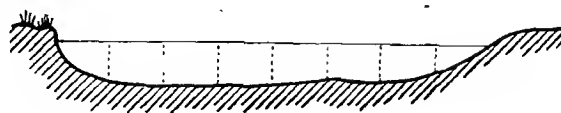
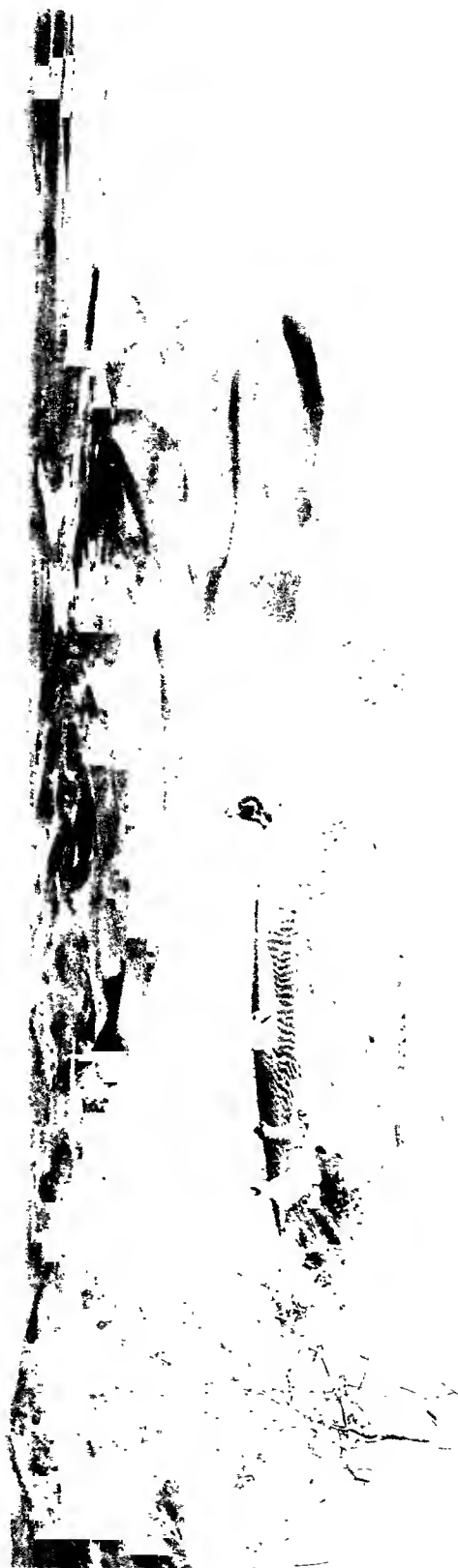


Fig. 135. Left. 2.02 2.20 2.29 2.22 1.82 2.08 1.42 = depth. Right.  
 97 90 113 91 104 158 120  
 97 90 93 81 106 151 130 } velocity. \*  
 110

Breadth = 23.46 m. Ugen-darja, Dec. 5. Scale 1:400.

\* In this case, in consequence of drift-ice, the velocity of the surface-water was measured by aid of chronometer and length of canoe.



*Ljustr. A. B. Lagretius & Westphal*

VIEW LOOKING N.W. FROM THE SMALL SAND-DUNES BETWEEN THE UGEN-DARJA AND THE TARIM,  
CLOSE TO THEIR CONFLUENCE.

The Dunes are more or less bound by Tamarisks. In the background is the Ugen-darja, with the Kamisch Huts of Karaul on its Right Bank.  
On the Left are shown the Swamps between the Left Banks of the two Rivers





The Ugen-darja had at its embouchure a breadth of 23.46 m., a mean depth of 1.756 m., a mean velocity of 0.22 m., and a volume of 9.063 cub.m. in the second. These measurements are not, however, quite reliable, since, owing to the extremely slow rate of flow, I was unable to measure more than the surface velocity, by calculating the number of seconds taken by a float to move from one end to the other of a 4.55 m. long canoe held fast by an anchor. The datum for the volume is therefore, by assumption, too great; the real result would be one or two cubic meters less, or, let us say, about 8 cub.m. in the second. At this time, however, none of the water of the Tarim was making its way up the bed of the Ugen-darja, as we were easily able to satisfy ourselves at a shallow ridge or shelf which crossed the latter stream a little way up. The Ugen-darja is indeed the deeper of the two; but there exists no reason why the water of the Tarim should penetrate up it, for all the way up the Ugen-darja stands at the same level as the Tarim itself.

The two rivers always stand therefore at the same level in the way shown in fig. 137. When the Tarim rises, the Ugen-darja must rise too, for the latter receives, as we have shown above, several arms from the main stream. When the Tarim drops, after the spring freshets are gone, then the Ugen-darja likewise drops to its lowest ebb.

In respect of their morphology there is a great difference between the two rivers. Whereas the left bank of the Tarim is 0.49 m. high and almost perpendicular, and its right bank flanked by flat alluvial deposits, the two banks of the Ugen-darja are of precisely the same height and precisely the same degree of steepness. Their height is half a meter, and the ground, an arenaceous clay, almost perfectly horizontal, the slight fall which it actually has towards the east being imperceptible to the eye. The sand-hills and conical elevations, which diversify the flat surface, are entirely of secondary formation, that is to say, they have been built up on the level base by the wind.

At the confluence of the Ugen-darja, the mean depth of the Tarim was 1.362 m., and of the Ugen-darja itself 1.756 m. The latter had therefore an average additional depth of 0.394 m.; but, if we consider the maximum depths of the two rivers, the difference is 0.560 m. This fact is deserving of consideration. At the same spot the mean velocity of the Tarim was 0.74 m., and its maximum velocity 1.20 m.; and the Ugen-darja had a mean velocity of 0.22 m. and maximum velocity of 0.27 m. in the second. That is to say, the main stream was three to four times swifter than its tributary. One would expect to find, therefore, that the proportionally greater erosive power of the former would have produced a proportionally deeper bed; whereas in point of actual fact, the Ugen-darja, whose erosive force is practically nil, possesses a deeper and more distinctly excavated bed than the Tarim. The only explanation of the phenomenon that I am able to offer is, that, whilst the Tarim's excavating force is very insignificant, its power of forming alluvial deposits is on the contrary very strongly developed. A river which flows with a mean velocity of 0.74 m. in the second does of course exercise a certain amount of erosive energy, otherwise it would very soon cease to exist; but such erosive energy as it does exhibit is exceeded by its power of making sedimentary deposits. The erosive power of the high-water is at least three or four times greater than that which

was being exerted by the river when we observed it, but at the same time the deposition of sand and silt is also proportionally greater. The mud flats which we saw exposed over such a wide area do not retain the same positions two years in succession, but keep shifting and changing, except in those reaches in which the river traverses an old and tolerably fixed channel. Yet even there, as elsewhere, the material of which the several individual deposits are composed has travelled down the river. They are washed down by the high flood, but then the high flood deposits fresh material in their places. That the river is never deficient in material to deposit, we have already seen. Not only is its water always very turbid, but it flows, especially in this part of its course, close to the high dunes, frequently sweeping along the face of its outliers and sucking in enormous quantities of sand. The coarse sand of course soon settles to the bottom, not very far from the spot where it has been caught up by the stream; but the finer material is transported some distance down, and the finer it is the farther it travels. It is the very finest dust which keeps the river always so muddy; yet even it too must settle sooner or later, for the Tarim has no outlet to the sea. This circumstance supplies us indeed with one of the chief factors for the solution of the Lop-nor problem, that is to say it is one of the causes of the migration of the Lop-nor, as well as of the river's instability and tendency to shift its bed. Even if we disregard the coarser sand, it is perfectly evident, that the finely comminuted material which for countless centuries the stream has carried down in suspension must have resulted in the deposition of immense quantities of solid matter in the lower-lying parts of the system; while on the other hand, the force of erosion in the higher-lying parts has tended to produce the contrary effect, by constantly loosening and removing the soil, and so lowering the river-bed. Not only does the Tarim in the lowest parts of its course wage successful warfare against the sand, but it also levels down the country it flows through. Indeed, the shifting and washing away of the sand-banks is a direct consequence of the energy of erosion. Nor has this ephemeral erosion escaped the observation of the half-civilised natives: they call it *kum* or *laj kaulaghan-su*, that is »the water digs down into the sand or clay«. But they push the explanation too far, when they assert that the drop of some centimeters which sometimes takes place during a single night is caused by an equivalent volume of the current having scooped out a place for itself in the bottom of the river, or in other words by a corresponding quantity of sand and silt having been removed from the bottom.

The deposition of alluvial material being thus in excess of the effects of erosion, it follows that the river-bed becomes increasingly filled with sediment. Consequently the channel is raised year after year in relation to the flat country adjacent to it, until finally the stream runs over and seeks a fresh path for itself. When the stage is reached in which the accumulation of sediment is so great that the river has no longer any choice, but *must* run over, then a *jangi-darja* is formed like those which we have more than once considered above, and such as we shall find yet other excellent instances of lower down.

But it is more difficult to discover a perfectly satisfactory explanation of the deep, narrow bed of the Ugen-darja. The reason why it does not get filled with sand and silt is no doubt the sluggish character of its current, depriving it of the

power to carry sedimentary matter. To this it might be objected, surely at the season when its volume, like that of the Tarim, is far greater than it was in the autumn when we saw it — surely it possesses then the necessary transporting power! But under such conditions we should of course expect to find its bed shaped in the same way as the bed of the Tarim, and alluvial deposits to be formed at least in the convex angles of its windings. And yet these are entirely absent; the river presents everywhere the same steep banks, without alluvium, that it does near its confluence with the Tarim. How then are we to account for it, that the river resembles an artificial canal, being of almost one uniform breadth throughout, and everywhere deeper than the main stream? That the channel is not the result of erosion, effected under conditions such as those which now prevail, is clear, for if the stream is not powerful enough to carry in suspension the most finely comminuted particles of matter, manifestly it can possess no erosive power. The following theory, which I have hit upon, conveys, so far as I can ascertain, the only likely explanation that meets the circumstances of the case.

The Ugen-darja is a very old stream, and coincides with the direction taken by the principal artery of the Tarim system at an earlier date: that is to say, all the water of this system flowed anciently down the bed of the Ugen-darja. For, as compared with the Ugen-darja, the existing Tarim is a new creation. Above Karaul the ancient river travelled through the district in which the Tschong-köl is now situated, and then continued along the channel which is at present used by the Intschkä-darja to reach the Kontsche-darja; then, crossing over Jing-pen, it flowed eastwards through the bed now known as the Kuruk-darja, in the way that I shall describe in detail in a later chapter; and finally it issued into the ancient Lop-nor. The Ugen-darja is thus the last remaining section of a portion of the ancient Tarim — a fragment of a river, a *flumen relictum*, in no sense a moribund or dried up waterway. On the contrary, it is a stream the energy of which has shrunk to insignificance, and has become converted into a mere conduit for the passage of such water as chances to find its way into it. Streams of this character are quite common in the terminal regions of the Tarim hydrographical system, and we shall subsequently have to deal with far more pregnant examples than the Ugen-darja. In fact, these streams form a distinctive type of river; they are nearly always accompanied by luxuriant vegetation, except where this has been smothered by the encroaching sand. They put me to some extent in mind of the creeks of the Schat-el-Arab at Basra, which plough their way through a perfectly flat and level country, as I observed when I visited that part of the world in 1886.

The existing Ugen-darja is, in my opinion, the deepest eroded trench\* or *thalweg* of the ancient river, that is to say, of that part of it which always carried actually running water, winter and spring alike. The existing Tarim, like every other river, has of course somewhere or other in its course a similar trench; which

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\* The lowest extremity of the Ugen-darja is not however so old as the rest of the river, in which the depth is so considerable, and the banks of which I found in 1896 to be 6 m. high. When the stream abandoned the Kuruk-darja channel, the Tarim separated from the Schah-jar-darja or Tscha-jan at Tschong-köl, and swung away to the south-east. Above the district of Tschong-köl therefore the Ugen-darja is older than the section between Tschong-köl and Karaul.

constitutes the outlet for what the Germans call the *Stromstrich*. In the accompanying sketch (*d*) of the district of Intschkädige-tam, the shaded portion represents the deep trench in the river-bed. Owing to the inertia of the water, this trench exhibits a tendency to follow the peripheral outlines of the river-bed; or, more precisely, a tendency to traverse each loop round its outer periphery. Consequently between every two loops it crosses the channel; as a result of this, its outline, taken as a whole, is even more serpentine than the bed of the river itself. This is distinctly seen upon comparing the accompanying sketches; of which (*a*) shows a section of the Tarim across the Ak-su-darja, below the confluence of the Jarkent-darja, at the period of high-water, when the bed is filled from brim to brim; (*b*) a section of that part of the river which contained water on 29th October; while (*c*) shows those parts of the river which are under water at the period of high flood only. The deep trench, which winds between these shallower parts and always contains water, although in spring it shrinks to an even smaller compass than is shown in the sketch, is precisely what answers to the existing stadium of the Ugen-darja. All that now remains of its ancient bed is just this deep trench, the analogue of that depicted on (*b*), its alluvial deposits (fig. *c*) having been long ago levelled down, and their sites overgrown with vegetation. When a river-bed of this character is deserted by its ample stream and the alluvial deposits are no longer overflowed, reeds,

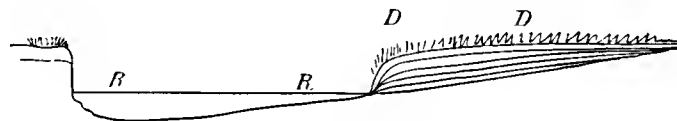


Fig. 136.

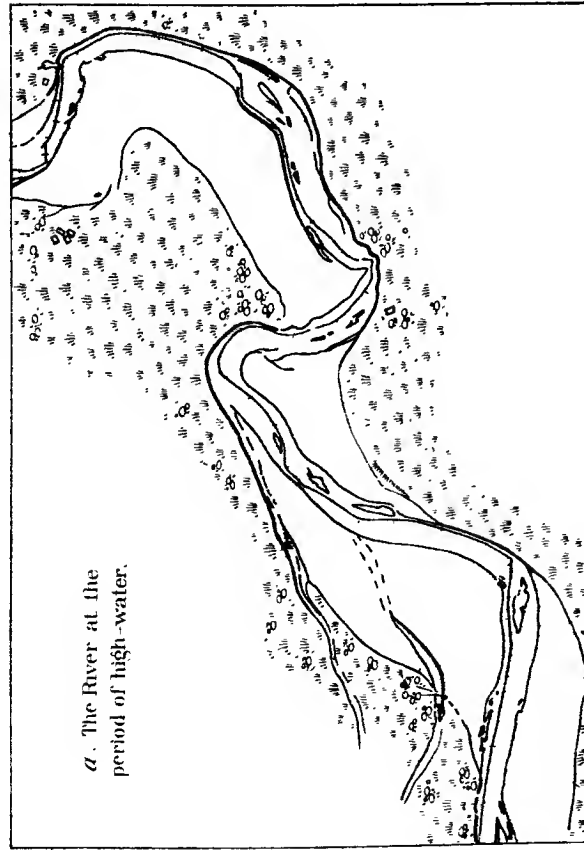
bushes, and other vegetable growths find their way to the exposed sedimentary matter before it has time to dry. These, advancing to the water-line, restrict the channel still more; the roots consolidate the loose material; decaying vegetation, drift-sand, and dust pile themselves up as the years flit past, until a river-bank (see fig. 136 D) emerges, and finally all that is left of the original stream is the primary eroded trench R, which, like the original river-bed, is deepest in the loops, but shallowest where one loop passes over into another running in the opposite direction. An essential condition of the occurrence of a metamorphosis of this character is that the restricted channel shall in future still continue to discharge its function as an outlet for water, otherwise we get the result known as an ordinary *kona-darja*, that is an abandoned bed, which therefore within a short time dries up and becomes overgrown with vegetation, or, like parts of the Opghan-darja, becomes filled with sand until it is completely levelled up.

Another type of river is afforded by the Kuruk-darja, which has, I dare say, been deprived of water from time immemorial, but is still distinctly traceable, for it has not been inundated by sand, while at the same time all vegetation has completely died out along its banks. If now we were to imagine that the same fate which has overtaken the Ugen-darja were to overtake the section of the Tarim, as depicted in the sketch above, the final result would be precisely the same as in its case — a deep, narrow trench or gully without a trace of alluvium. Still, one would

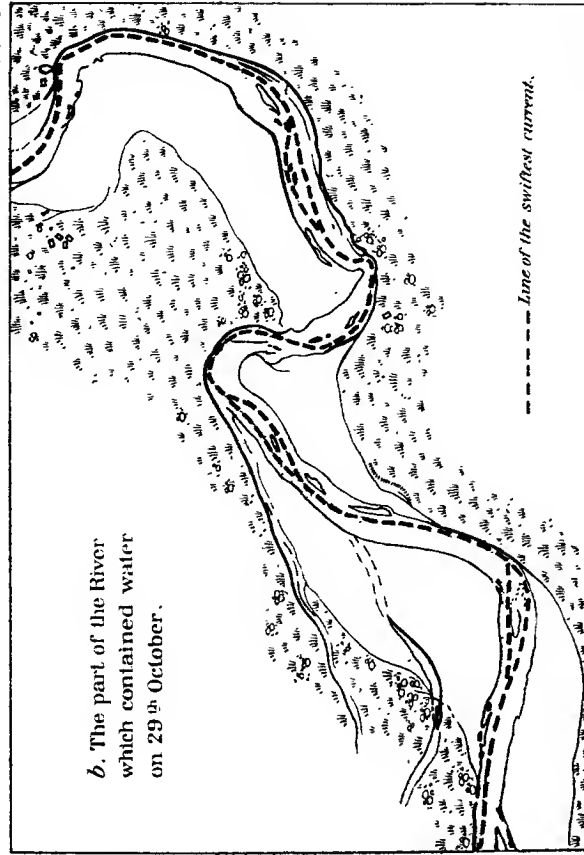
# The Tarim River at Intschkä-dige - tam

Dr. Sven Hedin: Journey in Central Asia 1899-1902.

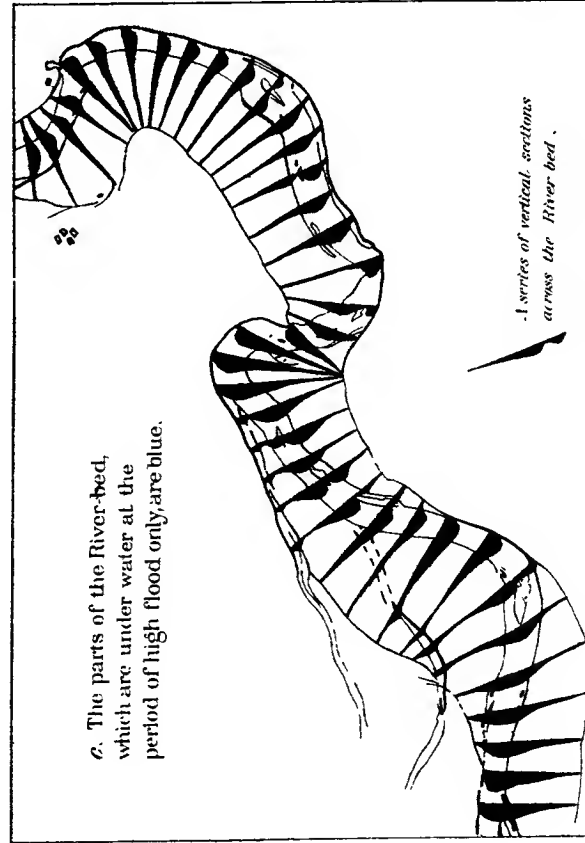
Pl. 29.



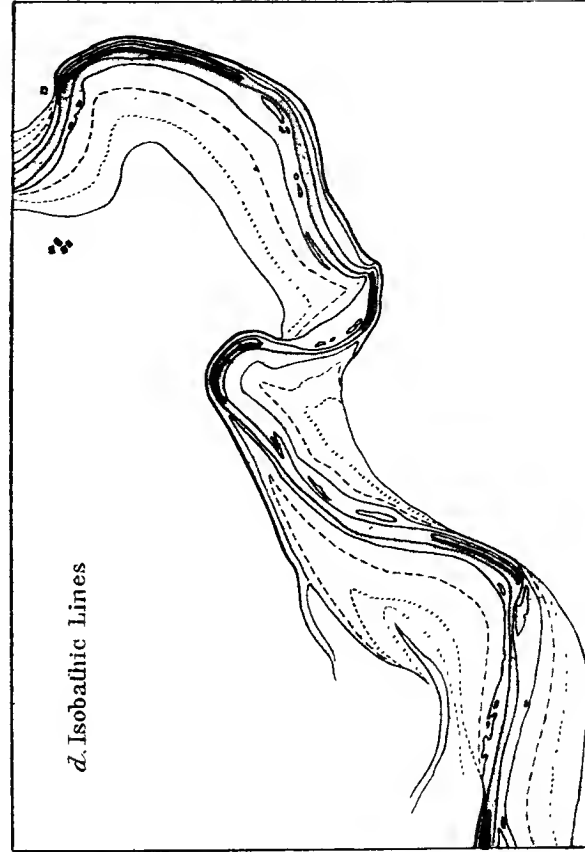
a. The River at the period of high-water.



b. The part of the River which contained water on 29<sup>th</sup> October.



c. The parts of the River-bed, which are under water at the period of high flood only, are blue.



d. Isobathic Lines



imagine that in process of time a river-bed like that of the Ugen-darja would become choked with dust, drift-sand, and decaying vegetation; and possibly that is taking place, though at an extremely slow rate. Besides, the high water pretty certainly possesses sufficient force, by its mere movement alone, to keep the channel open, and prevent it from getting choked up in this way.

Hence, with regard to rivers of the type of the Ugen-darja, Intschkä-darja, and Schah-jar-darja type, we may affirm, with perfect confidence, that they are old, at all events considerably older than those channels which are at the present time copiously furnished with running water. In these latter the stream ebbs and flows, rises and falls, there is a very considerable range between the high-water level and the low-water level, the velocity is great, the energy in every respect actively developed. In rivers of the Ugen-darja type, on the contrary, the difference of level is slight; and even when the high flood causes a rise of about 1 m., the velocity is not appreciably quickened; and the activity of the stream is never under any circumstances lively. But a rise of 1 m. in the level of the Tarim is fraught with incalculably wider-reaching consequences, as will be apparent from the accompanying illustration. U stands for the Ugen-darja; T for

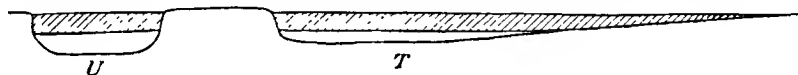


Fig. 137.

the Tarim. A given section of the Ugen-darja contains, in most cases, in a given interval of time, a larger volume of water than a similar section of the Tarim, considered for a precisely equal interval of time.\* All the same, the quantity of water which flows through the Tarim is — it was so, for example, on the 5th December — six times as great as that which flows through the Ugen-darja. The Tarim is therefore the active stream, the river of aggressive energy; while the Ugen-darja is the more passive, relatively inactive stream — a mere conduit, so to speak, for the passage of water on its way from higher to lower ground. And as no changes take place in the bed of the latter, such as the laying down of sedimentary deposits, the current consequently maintains its direction unaltered. And the same observation holds true of those old river-beds which still preserve a relatively flickering remnant of life. If for any cause the supply of water ceases in a channel of this description, the pools in it nevertheless persist for a pretty long time in its deeper parts, though eventually they, too, dry up completely. After that the watercourse still survives as a deep gully or trench. Of these also we shall find instances in the region of the Lower Tarim.

\* This does not hold good, however, for the very lowest part of the Ugen-darja, for the stream is there much shallower than it is higher up. A cross or vertical section of the mouth gives an area of 41.20 square m., while a similar vertical section of the Tarim measures 74.78 square m. But where the Ugen-darja attains a depth of 4 to 5 m. the case is different. In such places the cross sectional area of the Ugen-darja exceeds that of the Tarim, and as the former river is the narrower, every rise of level counts for more in the case of the Tarim than it does in the case of the Ugen-darja.



## CHAPTER XI.

## FROM KARAUŁ TO JANGI-KÖL.

December 6th. The transparency of the Ugen-darja was 57 cm. in the morning, that of the Tarim at 1 p. m. 8.6 cm. Barely more than half the surface of the latter was covered with ice. During the first two-thirds of the day's journey the river flowed remarkably straight, and during the last third it serpented very little. The sharp turn, however, by which it alters its direction from north to east-south-east, occurred just after we left Karaul. At the same time the stream rapidly assumes a different character. At first it widens out in two or three places to a great width, and is closely beset with alluvial deposits, as well as frequently divides into two or three arms. But finally it contracts again, and the sedimentary accumulations become few and far between; in fact, they are generally absent altogether, especially where the river assumes the appearance which is characteristic of the stretch between Arghan and Tschegelik-uj. The banks are rudimentary, seldom more than half a meter high, and both sides are pretty much the same height. The kamisch is very thin; the only places where it grows at all luxuriantly are a couple of marginal lakes. The predominant formation is now grassy steppe. Forest is altogether absent, except for a solitary poplar or an isolated clump of two or three — quite a distinguishing feature for this part of the Tarim. Even *kargha-jigde* (*Eleagnus*) is rare. Close to the left bank lies a series of low dunes, overgrown with vegetation, and intermingled with tamarisk-mounds. The sand on the right is now a long way off, though generally within sight; but towards the close of the day the river approached nearer to the sand on this side in proportion as it moved away from that on the left. The country was perfectly uninhabited, though occasionally we perceived a traveller journeying along the great highway from the Lop regions to Korla, the road running close to the left bank of the Tarim, between the river and the sand. The current was lively, and bore along our ferry-boat, which was encompassed with ice, at a smart pace. In several places poplar-stems, which came from higher up the river, were anchored in the mud at the bottom. The country was open, flat, desolate, and monotonous; the only thing to attract the eye was the endless chain of grinding, swirling, snow-white disks of drift-ice.

The first loop below Karaul touched the great highway at a spot called Nias Hakim Bek-tüschken, the name commemorating some chance rest there of the well-known governor of Chotan in Jakub Bek's time. Consequently the river has not in this place altered its course for at least twenty years. In this way the historical names prove not seldom helpful to the physical geography and its interpretation. Here the river becomes divided for a short distance, though the left branch is quite insignificant, and only carries water at high flood. At Kan-toghi there is an old dam, put down for the sole purpose of protecting the highway against inundation; for we have now reached the regions in which inundations occur with great readiness and frequency, and we get a foretaste of the inland delta of the Tarim. The next noteworthy place on the great highway bears the name of Kosch-muge. Jalghus-toghrak, the »Solitary Poplar», is a name which would only occur in a locality in which a poplar is a rarity and calculated to attract a certain amount of attention. In a similar way Kair-kotan, or the »Alluvial Hut», has its own tale to tell of an overflow which occurred here some time or other. All these names mark places on the great caravan road on the left bank of the river. On the right the Tarim sheds off the arm Basch-tam, which skirts the edge of the high sand, passing behind a small isolated belt of sand (*partscha-kum*, a »piece of sand»), but only carries water at the period of high flood. After passing through the lake of Teis-köl, the Basch-tam arm re-enters the river just above the spot where we encamped that night. From the left two artificial canals are led off to Dängsur-köl, a small lake densely packed with reeds, or rather a riparian morass, but is carried beyond it so as to supply certain pasture-grounds, whence the overplus of water is said to find its way back into the river of itself. Each canal is spanned by a bridge, one of them provided with a parapet; this is where they are crossed respectively by the great highway, which from this point gradually diverges from the Tarim. On the same side of the river we likewise passed a *kona-darja*\* (abandoned forty years ago), which within less than a day's stage again joins the existing bed. From this point onwards the current flowed faster, indeed it was as much as it could do to avoid breaking into rapids. In the expansions of the river and transverse extensions we felt the mass of water unmistakably gliding over cross-ridges or thresholds, now almost worn down to the level of the river-bed. A minor high-water branch runs between the right bank of the Tarim and the Basch-tam arm, but rejoins the former at Kara-dung; on the left there is a loop abandoned seven years ago. Here then we have an exceptionally clear proof of the river's continued deviation to the right, that is towards the south-west. We have the old channels on the left of the river, and on its right the two new arms, which, although they are at present only filled at the season of high water, will probably in the future each in turn be traversed by the main body of the river.

December 7th. Drop,  $\pm$  0. m.; transparency, 8.3 cm. at 7 a. m. and 9 c. m. at 1 p. m. The stream still continued to flow at a good rate, occasionally swiftly, so that we rapidly left the banks behind us. The drift-ice was very abundant and

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\* Farther on we shall learn more about the subsequent history of this watercourse. At Seit-köl I was told, that this reputed *kona-darja* of 40 years back is in reality only an overflow channel, which has succeeded to a canal that was dug twenty years ago by a certain Assan Bek.

covered the greater part of the surface; it was evident, that the river would soon be frozen over for good. The Tarim here flows very straight towards the south-east. On the left we have grass and kamisch steppe, and on the right the gigantic sand-dunes, towering up like small mountain-ranges. Generally speaking, the river is narrow; but in the loops which distinctly tend towards the right, or the south-west, it widens out considerably. These expansions are filled with deposits of sand, furrowed by creeks, which are all frozen wherever the water is stationary. The loop at Seit-köl is especially strongly marked, and picturesque; for with irresistible force the river has there carved a path for itself right into the face of the perpendicular dune-wall, which now overhangs the water. Even as we passed we perceived sand-slides taking place from the summit of the dune. The natives themselves have arrived at the conclusion, that the sandy desert formerly extended farther towards the north-east, but has subsequently been forced back by the river, literally washed away by its current, slowly but none the less surely, bit by bit. On the left we passed during the day's journey two or three minor high-water arms, besides a couple of small lakes, the Kok-ala-köl (at our camp) and the Potgho-köl. Immediately below the former there are two masars, one on each side of the river, and each surrounded by mounds bearing tamarisks. At Arelisch the Tarim is joined by a deep canal, only a few meters wide, and containing stagnant water, with tall reeds along its margins. This point, too, is interesting. Some of the natives assert, that this is the reunion of the kona-darja with the jangi-darja; others that it is nothing more than Assan Bek's canal. The former is, it is perfectly plain, the correct interpretation. What the country is like to the north-east of this district I am unable to say, because I have never visited it, and in the recollection of the natives changes which have taken place any length of time back have become blurred and confused. Probably the sequence of events has been something like this. In a far distant past the Tarim flowed south-east along the kona-darja, picking up the Kontsche-darja on the way. Subsequently, at some point to the south-east of the existing »root» of the Kona-darja, the river divided, sending its right arm to Arelisch. Into this the entire flood of the Tarim eventually found its way. Then, about 40 years ago, the new bifurcation took place, resulting in the formation of the jangi-darja. That this channel is relatively recent may be inferred from the absence of forest, while forest does accompany the old bed. Add to this, that from Arelisch onwards the existing Tarim is again lined by poplars, though they are, it is true, sparse; while from the same point the velocity decreases a little.

This day's journey carried us into a new and peculiar region, one which in respect of the eccentricities of its physical geography is probably without its parallel in the world. The stage between Kätschik and Teis-köl was indeed a kind of preparation for what was to come, or a transitional region between the two different types of country, between the woods and steppes of the Tarim and the region in which the river wages incessant war against the high sand. The name sandy desert alone connotes the almost complete absence of water; but here, in the portion of the river which flows towards the south-east, that element is present in actual superabundance. Not only are the two deadly enemies face to face, but they are actually engaged in a desperate struggle with each other, which has now gone on for



*Ljustr. A. B. Lagrelius & Westphal.*

DESERTED HUTS AT SEJT-KÖL.



a long time. The sandy desert does not allow water to collect on its surface. Throughout the whole of the interior of the Takla-makan Desert there is not a single drop of water; the precipitation there is miserably small, far from sufficient to effect the slightest change in either the character of the desert or the movement of the dunes. And just as little does the running water permit the sand to retain the positions it has won, but it breaks it down with irresistible power. Here however sand and water are so intimately in contact that to find anything comparable to them we should have to go to the coasts of those continents where dunes are being built up of sea-sand. It is true, there are fluvial dunes elsewhere, for example, in several of the big rivers of Russia; yet, compared with those of the Tarim, they are mere trifles, and both their origin and the part they play in the local physical geography are of a quite different character. For while the intimate relation of sand and water is in their case the relation of cause and effect, the contiguity of the Tarim to the great desert of Central Asia is rather of the nature of an accident: the two elements have causally nothing whatever to do with each other, and it is for this very reason, because they are antagonistic and dissimilar powers, that they come into hostile collision. On *a priori* grounds it is clear that a country which possesses two such active powers as these must be the scene of great geographical changes, as indeed will be demonstrated lower down. Similar phenomena are no doubt to be found in other parts of the world, *e. g.* the Amu-darja and the Sir-darja, though their sand-dunes are quite insignificant when compared with those of the Central Asian desert. A river that flows for a distance of 200 km. close to the base of dunes 90 meters high, which rise along its bank like an unbroken mountain-wall, is assuredly altogether unique on the earth.

Another phenomenon which began to make its appearance during this day's drift, though under special circumstances, was the occurrence of a whole series of lakes along the right side of the Tarim. These are entirely surrounded on every side by sand-dunes; in fact, they are like sheets of plate-glass embedded in an ocean of sand. During the day we passed the canals which lead to the first of these lakes, namely Tus-alghutsch-köl, Sejt-köl, Dasch-köl, Tana-baghladi-köl, and Talei Kullutschapghan-köl. I omit purposely the Teis-köl, for it is formed in an altogether different way, and consequently belongs to another type of lake. It is fed by the Basch-tam high-water arm, and is thus similar to the marginal lagoons which we have already dealt with, and which do not lie embedded amongst the dunes. All the others, however, which I have just enumerated constitute a distinct family or group of lakes *per se*, which, whilst not difficult to describe, are on the other hand very difficult to account for. But that I may not interrupt this description of the course of the Tarim, which is now pretty nearly at an end, I will reserve the treatment of these lakes for a future chapter or two. This will also afford the advantage, that we shall be able to discuss them in common, especially as regards their origin, and be able to compare them together.

The spot at which we went into winter-quarters is known as Jangi-köl, from a little village of that name situated on the right bank. The lake of Jangi-köl lies a couple of kilometers lower down. Over against the camp was the lake of Basch-köl, making a gap in the immense wall of dunes. Our camp, which was formed

on the edge of a little round bay that cut into the left bank of the Tarim, and made an excellent harbour, was also called by the natives Tura-salghan-uj, or the House built by the Great Man, also Tura-ottogho (= otak), that is to say the Great Man's House. This I merely mention *en passant* for the sake of illustrating how easily fresh geographical names spring up in those regions. At the head of our little bay stood a solitary poplar, these trees being here very sparse and sporadic, and all of them young; in this quarter there are no old and luxuriant woods. Steppe predominates; and there are strips of kamisch along the right bank at the spots where the river and sand do not actually come into contact.

Our reasons for choosing this precise locality for our winter-quarters were three. First, it was here I met my caravan, which had travelled *viâ* Ak-su and Korla. Secondly, I had resolved to make this the starting-point of a journey across the Tschertschen Desert, as described in a separate section of this work. The third reason, the most cogent, the river had now become completely frozen over, and prevented us from proceeding. The stream, now choked with drift-ice, which was more closely packed and more rugged than heretofore, did indeed continue somewhat farther, but in an expansion of its bed a very short distance lower down it was frozen fast from bank to bank. This first ice broke up again on the 11th December under the effects of a violent gale; but the frost soon recovered the upper hand and the river became permanently bound in its glacial fetters.

On the day just named I attempted to measure the volume at Jangi-köl, but found it impossible to accomplish it. A pole 8.61 m. long failed to reach the bottom; and the swiftness of the current and the pressure of the drift-ice both proved serious hindrances. The breadth, however, was 31.14 m. There were indeed some broad places close by in which the depth did not exceed two or three meters; but, with the exception of a narrow strip of water in the middle of the river, both banks were lined with thick, broad edgings of ice. At the spot where I obtained the measurement of 31.14 m. for the breadth, the velocity at 4 m. from the bank and at depths of 1, 2, and 3 meter, was 0.77, 0.88, and 0.90 m. in the second respectively. In other words, the velocity increased with the depth, a result attributable to the eddying movements of the water in the loop. Here in the eddy we were able to observe how actively erosion was at work, and in the spring of 1901 the strip of bank on which our camp stood was swept entirely away.

On the 15th December at the narrow passage I have just mentioned one-half of the river-bed was still open, that is to say on the side next the left bank where the current ran strongest; and even on the 20th Dec., the day I left Jangi-köl, there was a strip 4 m. wide still remaining open. Notwithstanding this, the river immediately above and immediately below our camp was on the 18th frozen so hard that the ice bore the weight of our camels.

On the 8th December the transparency of the water was 8.9 cm., but on the 15th no less than 19 cm., while the temperature at noon stood at +0°.1 C. On the 18th the transparency gauge registered 29½ cm., and on the 19th 21 cm. This was connected with another circumstance which I will briefly touch upon. Between the 8th and the 15th Dec. the level dropped 24 cm., so that the sheet of solid ice which filled our little bay subsided in the middle, forming a saucer-like

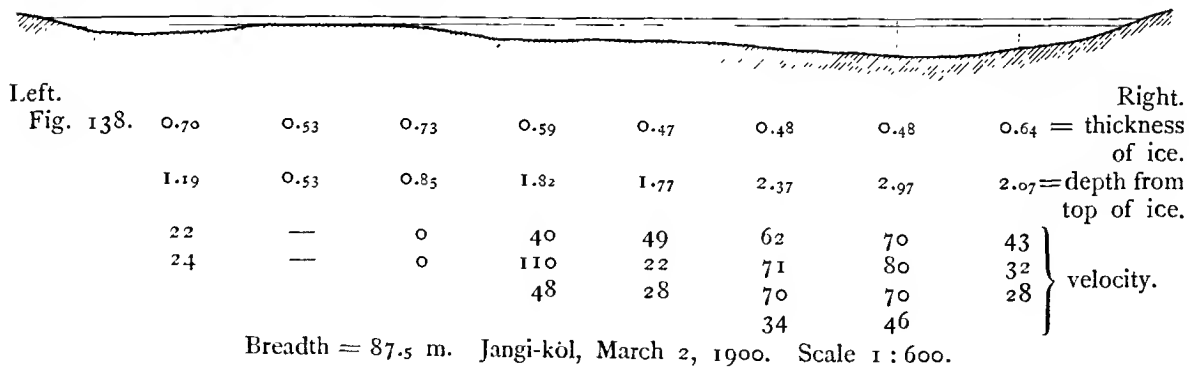
basin. Between 1 p. m. on the 15th and 1 p. m. on the 16th the river again rose 25 cm.; from 1 p. m. on the 16th to 1 p. m. on the 18th it dropped 28 cm.; but once more rose  $14\frac{1}{2}$  cm. during the following 24 hours. These rapid oscillations of level were of course caused by the freezing of the river. On the 8th December the velocity was normal; and the drift-ice had decreased in quantity. A good deal of that which still remained was forced in underneath the permanent ice that had already formed a little lower down. On the 15th there was merely an insignificant quantity of drift-ice left, and the current was so sluggish that we were unable to get a reading on the velocity instrument. This slowing of the current was the cause of the greater transparency in the water. The great drop which took place between the 8th and the 15th, or more properly between the 14th and the 15th, was caused by masses of drift-ice having become packed together in some narrow passage, thus causing an obstruction. And the rise which followed in the next 24 hours was due to the hindrance having been removed. The second subsidence was in like manner caused by a fresh stoppage, and this in its turn was succeeded by a rise of less magnitude, the quickened energy in the erosive activity of the river producing (on 19th Dec.) a diminution in the transparency of the water. This much by way of explanation of these violent oscillations, which no doubt decrease in amplitude quite suddenly. And there actually was a stoppage in the river, as I learned from one of my servants, who told me, after his return from Korla on the 16th Dec., that for a long way below that town the highway was flooded, in consequence of the river's getting frozen and of the stoppage caused by the drift-ice.

But the real cause of the extremely great retardation in the rate of flow would appear to be the fact that the ice, which now covered the entire area of the river's surface, as well as grew day by day thicker, increased the friction which the water had to overcome, by opposing to the layer that flowed immediately underneath the icy covering an opposition very nearly as great as that which the current encountered at the bottom of the river. The body of water was flowing, so to speak, through a tube, all round the periphery of which the velocity was equally slow, and the rate of movement quickest along the plane that was farthest removed from the inner surface of the tube, that is to say, midway between the ice-sheet and the river-bottom. Hence it was that the velocity was so slight on the surface in the open places. Add to this, that the process of congelation, which was just then taking place, naturally deprived the stream of considerable quantities of water, of course diminishing its volume to a proportionate extent. When, therefore, the stream is thus all at once checked in its flow, and the power of gravitation which carries it down its bed is to a certain extent nullified by the frost, it is clear, that in the spring, when the frost comes to an end, the arrested gravitation resumes its effect upon the river, and carries through to a successful conclusion the labour which was suspended at the beginning of winter. The velocity becomes therefore greater in the spring than in the end of autumn, when the frost flings its icy fetters across the river, and the volume, notwithstanding that the influx of water from the contributories has decreased rather than increased, becomes a good deal greater than it was in December, owing to the water which has been held up by congelation being now set free again. The natives show that they have quite correctly inferred the cause of the first flood, the



spring freshets, when they call it *mus-suji*, or »ice-water«. And it is after this special effort that the Tarim exhibits its greatest slackening of energy and drops to its lowest ebb, which it attains when it has voided the whole of the thawed ice-water.

As early as the 26th February 1900 a little water made its appearance from up-stream on the surface of the ice, but eventually it, too, froze, and so increased the thickness of the already existent ice. On the 4th March, when the temperature of the air went up to 7°.0 C. in the shade, the ice began to give in earnest, and became so soft that one crossing it ran a risk of dropping through in treacherous places; and where the current was strong, there were even a few patches of open water. On the 2nd March we obtained the following measurements by chopping holes in the ice, the thickness of which varied from a maximum of 73 to a minimum of 47 cm. The breadth of the river was 87.5 m., its mean depth 0.994 m., mean velocity 0.4801 m., and volume 41.78 cub.m. in the second. Upon comparing these results with those of the last two measurements taken before the ice finally asserted its supremacy, we have, on 28th Nov. 67.22 cub.m., on 5th Dec. 55.33 cub.m., and on 2nd March 41.78 cub.m. The serious diminution of 11.89 cub.m., caused by the congealing of the river between the first two dates, was continued therefore, during the winter, and in the space of 88 days there occurred a further loss of 13.55 cub.m., or but little more than the loss which took place during the last week (8 days) previous to the river's getting finally frozen over. Thus the diminution of volume proceeded during that week eleven times faster than it did all through the winter. From this alone it is quite evident, that it is the congelation of the river which produces the diminution, and that the subsequent decrease of volume, which is very much slower, is caused by the ice growing in thickness day by day, thereby subtracting ever larger quantities of water from the river.



Owing to my departure on the 5th March, I was not present to witness the break-up of the ice, though I instructed one of my Cossack attendants to note carefully its various successive phases. On the 5th the ice was very soft and rotten, and on the 10th March what ice there was still left broke away from its moorings and went off down-stream with the current. The level was at that date 57 cm. higher than on the 8th December. The bulk of the flood went past on the 12th of March and two following days, filling the bed of the river completely, and overflowing all its alluvial flats. This was the *mus-suji* properly so called, or rather its



WINTER SCENERY FROM MY HEAD-QUARTERS AT JANGI-KÖL.



*Ljustr. A B Lagelius & Westphal.*

SUMMER VIEW OF THE SAME.



maximum stage. On the 15th March the river began to subside, and it continued to subside steadily all through the spring. When I returned on the 8th May I had another gauge-rod put down, and on the following day this showed a drop of 0.8 cm., and on the 10th it registered another 4 cm. Between the 8th and the 16th of May the river dropped altogether 15.1 cm., but by 9 p. m. on the 18th it had again gone up 7.1 cm. The natives, who have their own empiric indications, say, that when the *Eleagnus* begins to open its blossoms and the young wild-geese begin to provide for themselves, a slight increase becomes noticeable in the volume; though this increase is no doubt purely fortuitous, being rather connected with the pressure of the atmosphere.

On the 16th May 1900 I measured the river at the same place as I measured it on the 2nd March, with the following result — breadth, 84.59 m.; mean depth, 1.160 m.; mean velocity, 0.6729 m.; and volume, 66.03 cub.m. in the second, or 24.25 cub.m. more than on the 2nd March. Thus notwithstanding the passage of the spring freshets as early as the 12—14th March, the volume at the end of another two months was still considerable, almost precisely equal to the volume on the 28th Nov. at a place a little higher up the river. In the sequel we shall find various indications of the course which the spring freshets take through the bed of the Tarim, and of the effects they produce. Meanwhile, however, we have ascertained that in the locality where we now are, the river remained frozen three months almost to the very day, a result that was in perfect agreement with the statements which had been made to me by the natives at various points all along the river.



Fig. 139. Left.	0.58	0.37	0.53	0.89	1.27	1.87	2.11	2.12	1.86 = depth.	Right.
	12	19	33	40	71	91	106	100	91	} velocity.
	12	10	24	36	65	89	97	98	81	
					47	73	82	90	72	
						76	85	90		

Breadth = 84.59. Jangi-köl, May 16. Scale 1 : 600.

## CHAPTER XII.

## THE STRUGGLE BETWEEN THE RIVER AND THE SAND.

I left my head-quarters at Jangi-köl for good on the 19th May 1900 — I say deliberately »for good», for, as I have already intimated, the ensuing spring flood washed away every trace of our camp, with its peaceful huts. And now began a fresh phase of this long river journey. In the part of its course which we now entered upon it was even more fickle and, as it were, groping than we had yet seen it, the masses of water seeking tentative paths, forming temporary lakes, and ploughing out new channels. Down to this point the river had formed a simple and distinct stream; but now the hydrographical system became much more complicated. The spring freshets were, however, of great advantage to us; for, still pouring down the river in considerable volume, this *mus-suji*, or »ice-water», carried the ferry-boat along at an accelerated rate, greatly smoothing our passage, as well as affording me an opportunity to study the river under a fresh aspect, and supplying me with additional materials for this biographical sketch of its annual career. The flood was both powerful and imposing, the river-bed now expanding, now contracting, as the stream rolled on past the alternately opening and closing *coulisses* of the bright yellow dunes, thrust forward by the sandy desert. All we perceived of the marginal lakes was every now and again the openings of the canals which lead into them. Reeds and forest undergrowth were again dight in all the glory of their summer greenery. The poplars, however, were still comparatively scarce, growing either singly or in small sparse groups, and, except for maybe half a score, all quite young trees. The colouring was strong, and the reflection of the light upon the water dazzling; but let a tempest break, and everything becomes shrouded in gloom, and for a day or two afterwards the landscape wears a greyish tint, and the light is diffused. Thus perfectly clear days are a rarity at this season of the year.

Our first day's drift carried us to Karaunelik-köl. Along this section the river runs very straight. Generally there is a narrow belt of reeds between its right bank and the extremity of each successive chain of dunes. But the only spot where the river actually assails the base of the dunes at all violently is where the sand is heaped up between Gölme-käti and Emin Achune-uktusu. The photographs which I have already given of Tokus-kum might readily pass for the abutment of any-

one of these chains, for they occur with astonishing regularity, and are almost exactly alike, except that some of the dunes are not quite so high as their neighbours, and some of the south-western loops of the river eat a little deeper into the sand than the others. The accompanying illustration (fig. 140) shows one such loop drawn in vertical section. Having doubled the point where the river comes into contact with the leeward side of the dune, we find ourselves within a few minutes broadside on to the steep, concave wall, which towers up on our right at an angle of  $32^{\circ}$  to  $34^{\circ}$ . From its summit the dune slopes away very gradually to the windward end of its long axis; but the altitude of the dune-wall does not decrease so slowly, for the river, bending round to the north, does not come into direct contact with the lower parts of its windward slope. Thus it is only the windings which are pushed out towards the south-west that actually touch the sand; those that penetrate north-east travel on the contrary away from it. One observation we made here, and repeated on many occasions subsequently, is, that in such places as these the river is very much broader than elsewhere. The moment it strikes the foot of a dune abutment, it begins to widen out and grow shallower; but as soon as it leaves the dunes, and flows through sand and soil that are held together by vegetation, it at once contracts and becomes narrow. Hence, as a rule, the south-west

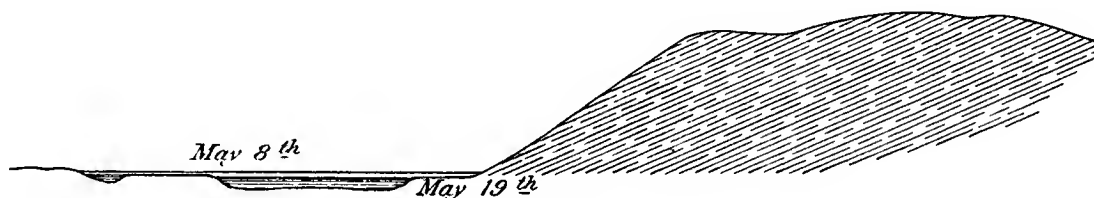


Fig. 140.

loops are broad, the north-east loops narrow. The ultimate cause of this is to be sought in the masses of sand which glide down the dune-side, and are swept away by the current. The heavier particles settle of course at once, forming the sand-bank which is generally found at the foot of every dune-ridge washed by the river. The lighter particles are carried a little farther away, but they too soon drop to the bottom. In this way the river-bed gradually becomes filled with sand, making it at once shallower and broader. Intermingled with the sand however are particles of finer, lighter dust. These, together with the lightest particles of the sand itself, are held in suspension by the stream, until it deposits them some distance lower down in some still, reedy lake. In these loops the river is therefore especially muddy; and there too we incurred the greatest risk of running our ferry-boat aground. When on the 8th May I was paddled up-stream in a canoe, this particular sand-bank was under water; but when I returned on the 19th it was just about exposed, the water having in the meantime subsided. There is also just at this same spot a large strip of alluvial mud close in under the left bank.

Otherwise within the short space of eleven days the river had changed but little in appearance. On both occasions I mapped the river, in order that I might institute a comparison. Both maps however agree in their details; the only difference

between them is that, from the superior elevation of the ferry-boat I was able to note various sedimentary islands and channels running through the alluvium which had escaped my observation when I sat in the lower-lying canoe. Thus the map gained from being laid down from the platform of the ferry-boat, for this big craft, which was entirely dependent upon the current, was carried in and out to the far extremity of every bend, whereas the canoe-men generally took short cuts by paddling across the shallower places.

On the left we passed first a canal, leading to Kara-tschatsch and Katschkene-dschajiri, two uninhabited homesteads; below them there are no inhabitants except shepherds. On the 8th of May this canal contained a little water, but by the 19th it was all gone and the canal was dry. Immediately opposite, on the other side of the river, there is a tiny lake, Motel-uktusi, scooped out of the level ground, with reeds all round it, but high sand at its south-west angle only. Beside it stood formerly the village of Jangi-köl, and the site is still called Jangi-köldake-kona-uj. Farther down on the left is Jamandake-uj. At the eastern foot of the spur of sand, which touches the eastern shore of Gölme-käti, stands the deserted homestead or village of Nias Supa Bajne-uji. On the left of the river are two other homesteads, Dovlet Bajini-uji and Talei Kullunu-kötschetu, with a canal leading from the river. Two other canals, still on the same side of the Tarim, connect with the little lake of Bajini-kölu, and two homesteads that stand beside it. Immediately below this comes the lake of Kaghune-kölu. On the north-west shore of the Karaunelik-köl are several huts, which have been unoccupied for fifteen years.

On the 20th May we did not get any farther than the entrance to the lake of Ullugh-köl. On the left bank stands the *mähallä*, or »village», of Ullugh-köl, also known as Ilias Murabne-mähallä, with 20 to 30 families. One half of this population, who are estimated to number 300 persons in all, dwell in Ak-tarma; the other half in this village, which we saw a few hundred meters back from the river. At a place called Ak-jolu-basighi the flood-bank of the river is a couple of meters high. On the right we noted a canal which goes to Tajiri-kakmasi and Ullugh-köl; both times when I passed it was empty. On the other hand the Tägirmän-arighi, on the opposite side of the river, carried water on the 8th May; this watercourse proceeds first to the mill of Ullugh-su, and then empties into the old river-bed of Kudschek. This last is now perfectly dry, although twenty-five years ago (1879) the Tarim poured its flood through it and then at Tunghan-tüschken joined the Ara-tarim (see below). Thus from this point the existing Tarim is a quite young stream; hence too we can understand the absence of poplar woods along its banks and the quite recent growth of such trees as do appear at intervals. This circumstance is not of course incompatible with the former existence of lakes amongst the sand; only then they must have been supplied by longer canals. And that there really were indeed lakes of that description is evidenced by the abandonment, it is said thirty years ago, of the village of Kona Ullugh-köldake-uj, situated beside the upper canal (*baschi*) of Ullugh-köl. Here we noticed, in the face of the perpendicular scarped bank, two distinct water-marks, at 84 and 23 cm. respectively above the then existing level. The upper probably indicates the maximum level of the spring flood; the lower a level at which the river remains some time



*Ljustr. A. B. Lagrénus & Westphal.*

THE SAND-ACCUMULATION OF TOKUS-KUM.





stationary. We encamped beside the canal of Ullugh-köl. On the 8th May bright, crystal water was flowing out of it into the muddy river; but on 20th May a stream of 6.667 cub.m. was flowing *into* it, and so taxing the river to that extent.

May 21st. 1900. In the district of Ullugh-köl the river forms three sharp loops, one succeeding immediately to the other, like the limbs of the letter **M** or **W**. The neck of land at the base of the middle bend measures 95 m. across, and is called Artilma; while the name of Supa-Bek-ötgen-togh, at the vertex of the loop, proves that there was once a dam there, which has however been destroyed by the stream. The first of the south-going loops threatens, like that of Daschi-köl, to penetrate into the Ullugh-köl; while the second is making a violent attempt to undermine the abutment of sand which overhangs the east shore of the lake. Accordingly in this loop the river is as usual broader and shallower than in other places in the same locality. The next bend, going towards the north, furnishes an interesting observation. On the left shore of the bend there is a plant-grown dune called Arpa-kumgen-dung, or the Sand-hill of the Corn, and at its northern foot runs the old river-bed of Kudscek mentioned above. Immediately below this latter is a small detached patch of bare sand known as Ighis-dung, or the High Hill, with two or three deserted huts on its southern slope. At the foot of this hill again lies a lake, Kuntschekan-uktusu, not visible from the river, although connected with it by a canal which carries water at the season of high flood; this however was at the time of our visit stopped. Directly opposite is the gap in the wall of sand which gives access to Bajir-köl, and here is the little village of Muhamed Supa-uj, inhabited by two families of in all 13 persons. Even the names of the villages in this part of the country are merely temporary. In lieu of Bajir-köldake-uj, or the Homestead beside Lake Bajir, one may use equally well the name of the most important of its inhabitants, Muhamed Supa, who is still living there — a thing which can only happen in a newly settled country. But the interesting fact I desired to call attention to is the presence of barren sand-dunes on the left bank of the river. Were this not a fact out of the common, the dunes on that side would not be distinguished by special names. But this one, although it does not exceed 10 m. in altitude, is called Ighis-dung, or the High Hill. So far as I remember, the only other place along this section of the river — in which it makes its way past the desert lakes — where I noticed low dunes on the left bank was at Karaul. What, then, does this small surviving patch of sand tell us? If it fails to become overgrown, or be held together by tamarisks or other steppe-plants, it must ere long inevitably disappear. Well, it tells us, that at some time or other the country on the east side of the river was covered with sand too, although the greater part of it is now levelled down in consequence of the migration of the river and its tendency to divide into deltaic arms. We have but to imagine the river in some fit of caprice flinging itself into the basin of the Ullugh-köl, breaking through the rampart of sand to the south-east of it, and then returning to its present bed, at some point, say, below Kum-köl. Nor is it too bold a supposition to imagine the river breaking through the sand-dunes in this way, for not only is it supported by the river's tendency to keep shifting to the south-west, but we have with our own eyes been witnesses of a similar breach through the sand on the outskirts of the desert (Nov.

22d). The consequence of a breach such as I have supposed would be, within a very short time, to fill the Ullugh-köl with sandy alluvium and ordinary fluvial sediment. Within a brief period the river would adapt itself to its new channel in the ordinary way; but on its left bank there would remain three detached patches of high sand. Yet, as they would be threatened by the wind on the east and by the river on the west, their final disappearance would only be a question of time. They would continue to travel towards the west, and piece by piece would plunge into the stream, and be carried down with it, helping to form fresh sand-banks and raising the bed of the river yet higher. Meanwhile every storm which drives across these isolated outposts of the desert, thus cut off from the support of the other dunes, would lower their crests, and so force them another stage nearer extinction. The sand of which they are composed would not be able to reach, and reunite itself with, the sand that still remained on the other side of the river, except perhaps in the case of a small quantity of the finest and lightest particles. Arpa-kungen-dung and Ighis-dung are the last surviving fragments of dunes which have in this way been cut off from the expanse of the desert opposite. Now if this were a consequence of the river's migration to the south-west — in other words, if the river encroaches piecemeal upon the domain of the desert, one would expect to find

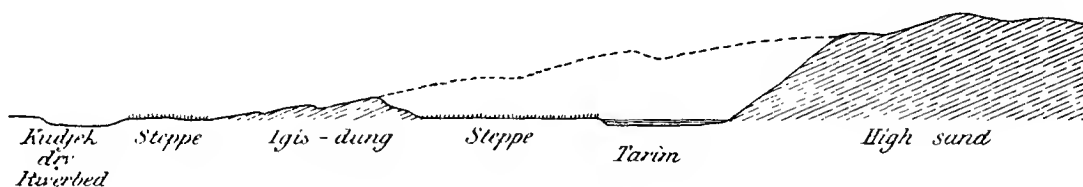
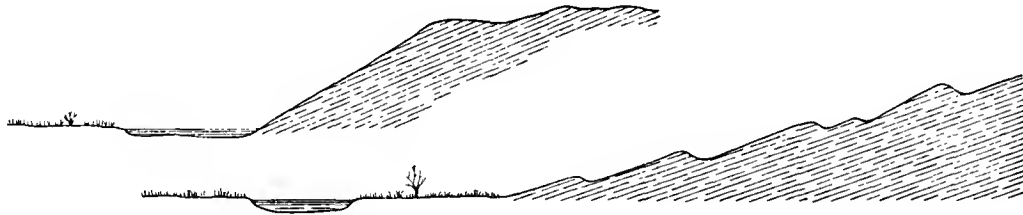


Fig. 141. PROFILE AT IGHS-DUNG. THE DOTTED LINE SHOWS THE ANCIENT POSITION OF THE SAND-ACCUMULATION.

these small detached patches of sand on the left bank far more numerous than they actually are. But no; they *must* of necessity be few in number, for it may be said that, as a rule, the river does not swallow the desert up slice by slice, but, as we have seen in so many loops, through its incessant erosive energy it gradually undermines it, and so advances slowly inch by inch. Besides which, we have also to take into account the speedy disappearance of these separated tracts of sand, and of the interlacing waterways and canals that are situated on the left-hand side of the existing river. Later on, too, we shall meet with a most striking instance of the river's power to cleave a path for itself through even the compact mass of the sandy desert.

It may be taken for granted, that the side which the sandy desert turns towards the north-east, in the direction of the prevailing wind, was not always so sharply defined, nor yet so exceedingly steep, as it is now. During the period that the section of the stream below Karaul flowed virtually due east, the dunes stretched farther to the north-north-east (see accompanying map), growing lower in elevation as they advanced, and finally ceased where the forest-belt beside the river begins. It is these extreme prolongations of the dune-ridges which have disappeared, some washed away by the river, others cut off by it. Ighis-dung is thus the last surviving fragment of the dune-ridge which rises between the Ullugh-köl and the Bajir-köl. And a

glance at my maps of the extension of the sandy desert will sufficiently prove, that this actually was the case, and that theory is here adequately covered by fact. The circumstance which carries the strongest conviction is that the steeper faces of the dunes are turned towards the river and towards the direction of the prevailing wind. Had the river been constant in its bed for, say, a couple of centuries, we should have had on its right bank a broad belt of steppe and forest, and the edge of the sand would have been some distance further back, while the slopes up to the culminating crests of the accumulations of sand would have been long and gradual. Moreover the flat zone between the river-bank and the beginning of the desert would have grown wider year by year. Instead of these features, however, we find the stream winding backwards and forwards through a very serpentine course, and advancing quite close to the margin of the sand, in places actually encroaching upon it. It would thus hardly be possible to have a clearer and more unmistakable proof of the fact that the river does move towards the south-west at a faster rate than the dunes do. It puts one in mind of a column of infantry cut down file by file by a troop of pursuing cavalry. Both forces are indeed advancing in one and the same direction, but the pursued does not succeed in getting out of the way, and is consequently destroyed. The power of the flowing water is inconceivably great

Fig. 142 *a*, *b*.

as compared with the power of the sand. Given sufficient time, the Tarim would be capable of mowing down the sand-dunes as a scythe levels the long grass.

As my map of the river shows in several loops, the right bank does not, at present, actually reach the sand. The contour is flat or slopes imperceptibly, and the surface is covered with sand and vegetation. From this we may conclude, that these river-windings have been permanent sufficiently long to allow of the dunes moving out of the way. The longer the river has been constant to its bed, the broader is of course the belt of flat land that intervenes between it and the sand. Hence there exists a striking difference in the profile (*a* in fig. 142) where the river comes into contact with the sand and the profile (*b*) where there is a flat belt intervening between the two. In the latter case the dunes rise up to their culminating crests by a long flat slope.

In a loop like that which is situated immediately below Ullugh-köl the currents of the river and the atmosphere dispute with one another the mastery over the sand. The latter is thus played upon by two forces, the power of the wind, which blows it away, and the power of the water, which undermines it. Sometimes one of these natural forces is predominant, sometimes the other; but in the long run it is the water which proves the stronger. The positions which alternately succeed one another

are exhibited in fig. 143 A, B and C. At a given moment the contours plunge down to the river at an angle of  $33^{\circ}$ . Then comes a storm, indicated in the fig. by arrows. The wind, driving horizontally along the earth's surface, comes into collision with the steep face of the sand-dunes, and the opposition it thus encounters compels it to alter its course *up* the slopes. But the ascent is too steep for even the most violent storm to produce any appreciable effect in the way of lifting the particles of sand upwards towards the summit of the dune. Consequently the lowest and middle zones of the steep dune-wall are scarcely moved or altered at all. All the greater therefore is the effect that is produced upon the highest zone: first, the sharp edge of the dune is rounded off, then it disappears, and then one layer of sand is swept away after the other. The wind thus tries to blow the dunes away slowly piece by piece. Assuming that the river meantime does not alter its bed, we have the result shown in fig. 143 A. After it has been exposed to a succession of storms following one another year after year, the slope of the dune assumes the appearance indicated by the darker shading in fig. 143 A. This is what we find to have actually happened in many of the loops, where there exists a more or less broad strip of steppe between the river and the outermost margin of the sand.

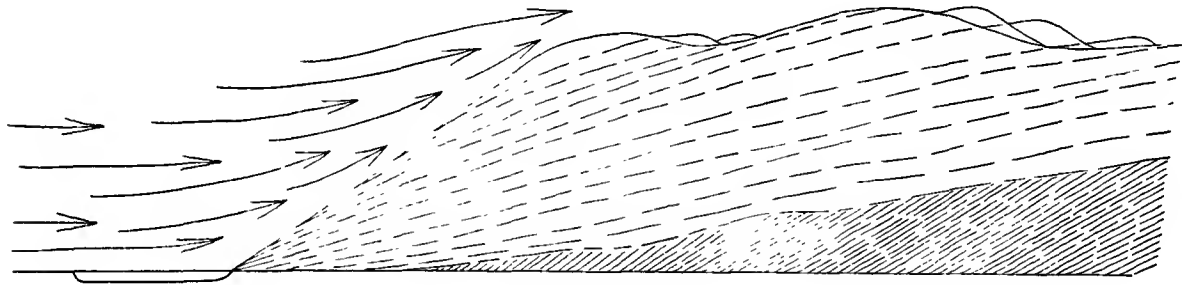


Fig. 143 A.

If now we assume the atmosphere to be quiescent, but the river to exhibit a period of exceptionally energetic activity, we should have the dunes undermined, and disappearing in huge sections, and finally the contours would be very much like what we see in fig. 143 B. But the assumptions made can only hold good for a very brief period, at the longest not more than a few months at a time, so that the actual contours are never so sharply drawn as in the fig. The line which indicates the beginning of the sand-slide always runs in a good bit under the culminating top of the dune-mass.

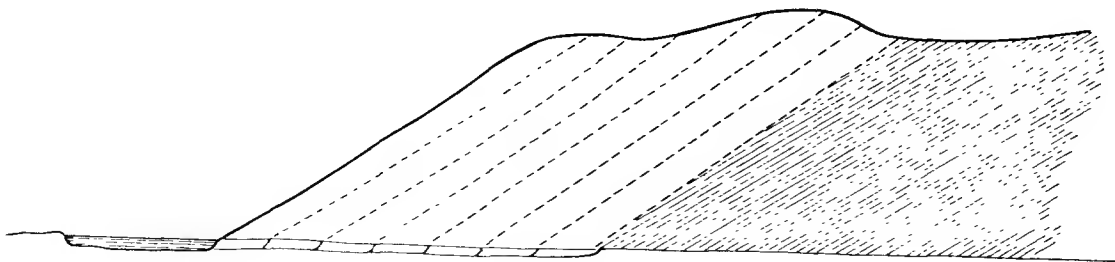
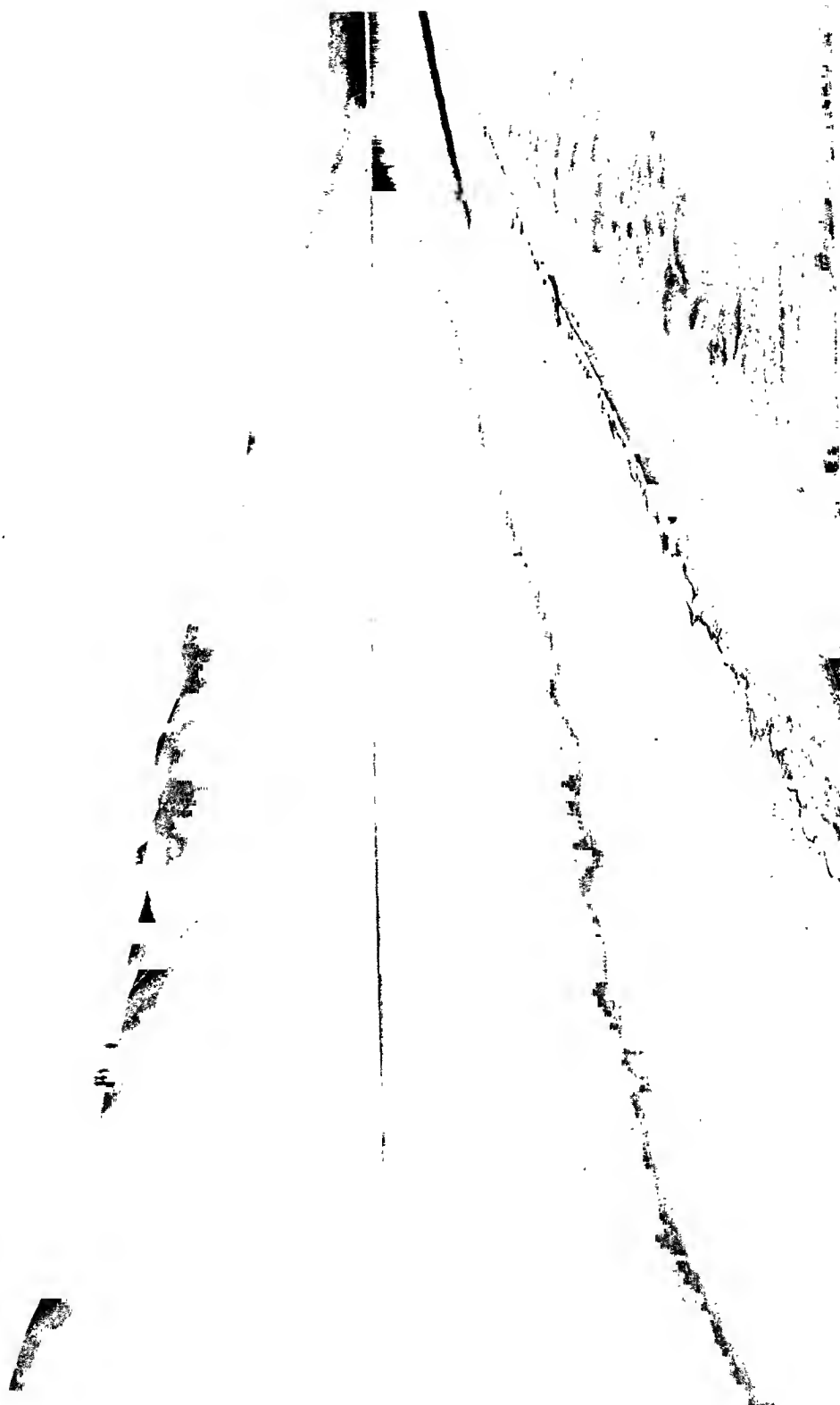


Fig. 143 B.



*Plate. J. B. Lagrelius & Westphal.*

THE WESTERN END OF THE SAND-ACCUMULATION OF TOKUS-KUM.



What actually occurs is shown in fig. 143, C; that is to say, both the disintegrating forces act turn and turn about. After a storm or storms have carried away the layer of sand (*a*), the river penetrates the dune-foot to (*c*), whereupon the section of sand (*b*) slips and glides down into the river, leaving behind it a fresh sharp edge between the steep slope and the flat dome of the dune-summit. After that comes a fresh storm, which sweeps away the layer (*a'*); then the river eats its way into the base of the sand as far as (*c'*), and the section (*b'*) in its turn plunges into the stream, which carries it away, either adding it to its existing sand-banks or forming new ones out of it. Meanwhile the loop increases in breadth precisely at the spot where these sand-slides have taken place. Finally the contours assume the shape shown by the stippling. All the rest of the mass of sand has been swept away, a part blown into the interior of the desert, but by far the greater part used by the river as an instrument for modifying the relief of the country through which it flows. When the river shifts its channel, the sand-banks it has deposited become gradually exposed, and serve as the foundation for river-dunes. These are, however, rare in the Tarim, and when they do occur they are so small that they may be disregarded in comparison with the immense masses and vast extent of the desert dunes. Where they do come into existence, they very soon get covered over with vegetation.

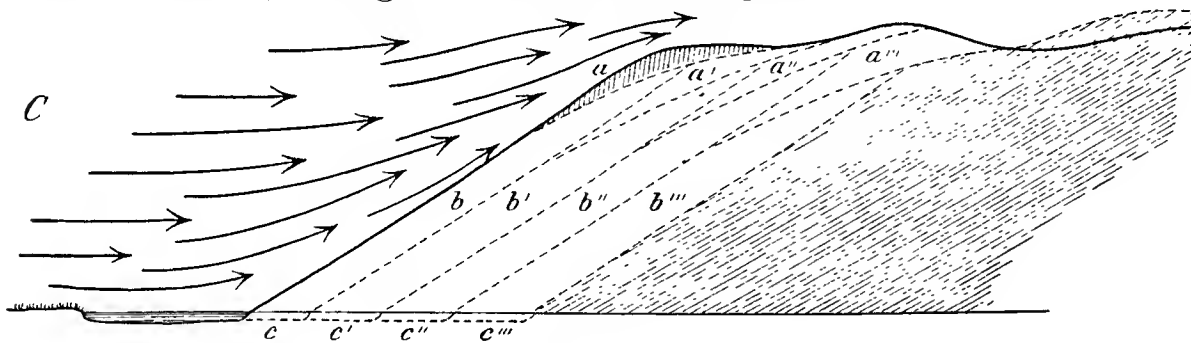


Fig. 143 C.

The order of the occurrences is, however, different in different parts of the same loop; a very illustrative example is afforded by the sharp bend to the south just below Jallang-dschajir. All round the outer periphery of the loop the sand descends into the river with the same degree of steepness, and the effect of the river's action upon it is uniformly the same throughout. But on the eastern side the sand would go down into the river even though the latter produced no effect upon it, for the wind drives it over and down upon the leeward side. On the west side, however, the wind conveys no sand into the river. On the east side the two agents work together towards the same end; the wind seeking to move the dune to the position marked (*a*) in fig. 144 and the river endeavouring to deposit it at (*b*). Yet the

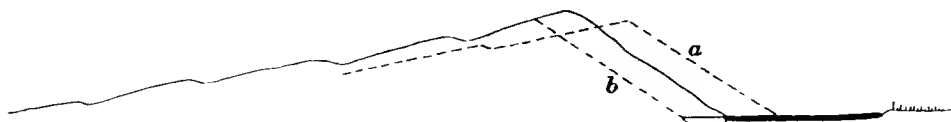


Fig. 144.



position (*a*) can never be attained, because the river seizes upon the sand which pours down the leeward side of the dune and at the same time continues its undermining energy. Hence this side of the dune is played upon, *ceteris paribus*, by the two agents of disintegration to twice the extent that the west side is.

On the 22nd May we had a fairly stiff gale from the south-west, its velocity being 7.3 m. in the second. Although the wind does occasionally blow from this quarter at this season of the year, it is very fickle, and its effect is trifling as compared with the overwhelming storms from the east-north-east. In those bends in which we had the wind in our favour we travelled at the rate of 1.52 m. in the second, a very fair rate of speed, considering that the utmost pace at which canoes can travel, and that in still water, is 2.1 m. in the second. It was quite a pleasure to see the banks slip past in this way; a pity though that the landscape was so monotonous, so devoid of picturesqueness. For even with the stupendous masses of sand and their sublime desolation one gradually becomes familiar. At first indeed they impress with a sense of awe and wonder; but after you have had them for your daily associates for months together, they become oppressive, and in the heat of summer produce a stifling sensation.

This day the sand was sometimes quite near to us, at other times farther away than usual, and several royal eagles kept circling above its precipitous flanks. On our left the steppe stretched away as level as the sea at calm, cheerless and grey, arid, dusty, overgrown with grass or short, scanty reeds; it was very rare indeed that we saw a clump of young poplars, and those but ill-thriven. When a »yellow storm» (*sarik-buran*) is blowing, the entire landscape becomes shrouded in the dust-haze; everything is grey and yellow, and the light faint and diffused. In several places we perceived the shepherds' camps around temporary huts, with their flocks and herds of sheep, cattle, and horses. The following names belong to the left bank — Muhamed-kälgen-kotan, Jurt-tschapghan, Ot-kalaghutsch-dung (the Hill where Fire is Kindled, *i. e.* some kind of signal-fire), Kaser Eisa Achun-tschapghan (a canal which starts at Kudscek and here re-enters the river), and Kona-kusch, now uninhabited. On the right we have the little lake of Jallang-dschajir, with the canal of Süsük-kok-alasi, which carries its water back to the river; the canal which supplies it with water is situated higher up. Again, on the left, we passed yet another dried bed of the Tarim, known as the Kona-tarim; it joins the Aratarim just below Tschigelik. I was assured, that seventy years ago one-half of the river's flood used to travel that way, but since then it has gradually gone over into its present channel on the west. But I ought to observe, that the dates one gets in this part of the country are not very trustworthy. One thing, however, is unquestionably true, and that is that the Kudscek, as well as the Kona-tarim, is an ancient bed of the Tarim. Very likely the stream has changed backwards and forwards periodically from the one to the other as they have become alternately choked with sediment, and this it may have done more than once, indeed several times. Both these ancient watercourses thread the country which intervenes between the existing Tarim and the Kontsche-darja. At the time when one or other of these beds was traversed by the undivided Tarim, the lower parts of the river-system had as a whole a more easterly position than now. Since that period the flood has ad-

vanced a gigantic step, or rather two or three gigantic steps, towards the west, for the presence of these old river-courses proves that migration has taken place not one stage only, but two or three stages. Here then we have a convincing proof of the theory I put forward several years ago, namely that the Tarim is moving to the right, that is to say, the lower Tarim is shifting its bed to the south-west.

The sharp bend which penetrates into the sand is known as Tung-lung-tschökön, or Tung-lung Sank, from a Chinese who was transporting wares down the river on canoes, but overloaded them so that they sank. On the left stands the village of Sin-mähallä, with a canal in which there was water. Opposite the next indentation into the sand an arik goes off to Kuslek, and near it stand some *Eleagnus* trees, some of them about forty years old. In the old bed leading to the Ara-tarim there exists a pool called Ak-iti-sokkan-tschol; here are some shepherds' huts, and a canal Chodai Vär-di-tschapghan, which supplies the lake with water.

May 23rd. On the left we passed Atschik-uktu, and on the right Lakulluktake-uj, situated on the canal which supplies Bajir-köl and its separate basins—Muhamed Aru, Dschan Nias, and Lakulluk-köl—with water. Just below this point is the beginning of a bed of the Tarim, abandoned five years ago, which ran along the foot of the high sand and reunited with the existing channel opposite the canal of Chodai Vär-di-tschapghan. About midway it is further connected with the existing Tarim by a canal Adoko-kok-alasi, which was dry when we saw it, but is in part filled with water at high flood. The country in the vicinity is called Adok-ottogho. This former river-bed demonstrates that the Tarim *can* indeed sometimes shift to the left. The probable explanation is that the river made such a violent assault upon the sand as to fill up and choke its own channel. The present channel too is of quite recent formation, for its poplars, which are indeed quite rare, cannot well be more than thirty years old. Even

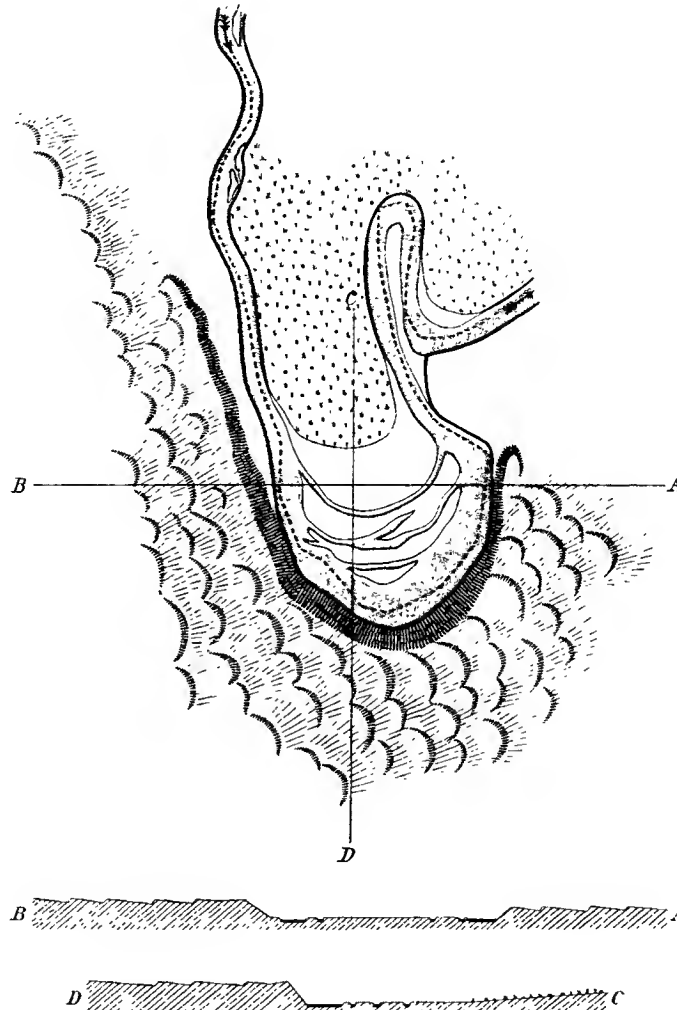
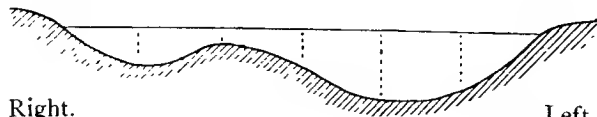


Fig. 145. THE LOOP OF TUNG-LUNG-TSCHÖKÖN PENETRATING INTO THE SAND; TWO SECTIONS CORRESPONDING TO THE LINES *AB* AND *CD*.

kamisch is wanting in places, leaving the river-margins bare and desert-like in appearance. The scarped banks are however quite high. On the left bank stands Kona-kuslek, a deserted homestead. Then comes the little lake of Muhamedne-köli, situated between the Tarim and the sand, and fed by a canal. Below it issues, through the right bank, another old river-bed, the Öttök-kaldi (the Forgotten Shoe), which was abandoned, according to one account twenty, according to another account thirty, years ago. From the existing stream we saw very distinctly, how it cuts its way into and across the sand. We shall, however, return to this old river-bed again subsequently. Opposite to it the Tarim sheds off an arik, Bulung-su, which pours water into yet another ancient channel, generally known as the Eski-tarim, which as late as three or four years ago was the chosen path of a portion of the flood of the Tarim.

It is hereabouts that the river-system begins to be more complicated, old river-beds and canals breaking away and rejoining the main stream at short and frequent intervals. We saw indeed their beginning (*baschi*) or their termination (*ajaghi*), but as for the remainder of their course we were obliged to accept implicitly what the natives thought fit to tell us. In the case of the stretch of river which I am now describing, I had however a certain check upon their statements, because I traversed it twice.

A short distance below Bulung-su the hydrographical system becomes more intricate than ever. On the right comes a *boldschemal*, or »backwater bed», now dry and dammed by a *togh*, or »dam», to prevent the water from entering it. On the left the river gives off a very small canal, the Kirtschin, which had on the 17th May a sluggish current and on 23rd May the following dimensions — breadth, 6.40 m.; mean depth, 0.463 m.; mean velocity, 0.2382 m.; volume, 0.71 cub.m. in the second. But its level, like that of the river, had dropped between the two dates. This canal empties into the Eski-tarim mentioned above; and the Eski-tarim, judging from the dense forest of magnificent trees which accompany it and which, when seen from the present river, looks like a dark wall, would appear to be an old watercourse. When the river is at its maximum, the Kirtschin supplies the Ara-tarim (see below), but at other times serves to irrigate the fields around the village of Ara-kum (Amongst the Sand, *i. e.* the sand which intervenes between the rivers), a village situated nearer to Tikenlik than to the Tarim. Quite close to this last the Kirtschin bifurcates; that is to say, it sends off a dry arm to the elongated lake of Kosu-kirgen-köl. This lake, again, which lies quite close to the Tarim, is also fed by four other canals, which follow immediately below the Kirtschin branch; one of them is especially large, and apparently in the high-flood season swells out to a stream of considerable dimensions. Yet two other branches, the lower and larger of



Right. Left.  
Fig. 146. 0.44 0.20 0.47 0.92 0.75 = depth.  
3 31 42 43 10 }  
36 45 3 } velocity.  
Breadth = 6.40 m. The Kirtschin branch. Scale 1 : 100.

which is called the Kosu-kirgen, restores the lake's overflow to the river. Each of these contained on 7th May a tiny rivulet, for the water begins to flow out of the lake the moment the level of the river drops below its own level.



DUNES ON THE RIGHT BANK OF THE TARIM, DEC. 1ST, SECOND LOOP.

In the Background Toghraik Forest; to the Left Alluvia carried down by the High Water off the Dune-accumulation on the Right



In the district of Tolotto-ottogho there is the beginning of yet another over-flow channel, which soon goes to join the Öttök-kaldi. This last is said at some time or other to have traversed a series of lakes, now dry, situated for the most part on this side of the great sand. A couple of deserted homesteads on the left bank are known as Ghaib Värđi-uji. The name of the right bank is Dadani-ottogho. Immediately below this lies the lake of Bobane-uktusu, with, on its upper shore, a small clump of poplars, probably fifteen years old. Poplars are however so rare in these tracts that I was able literally to map every clump, were it only of two or three trees together — nay, I actually entered every single solitary tree, so that, if I were to travel down the river again, I should be able to recognise every one individually. Some distance below the Kirtschin arm there are tamarisks, growing on their mounds, which have in many cases been surprised and cut off by the newly-formed river. In some places one can plainly see how the forest is in these regions disseminated; for poplars of one or at the most two years which have drifted down the river have here succeeded in fixing their roots on the very verge of the stream; and similarly of a quantity of bushes. In the old river-beds there is a good deal of drift-wood stuck fast in the mud at the bottom, trees projecting half their length above the surface of the water: this is especially the case in the vicinity of the Bajir-köl.

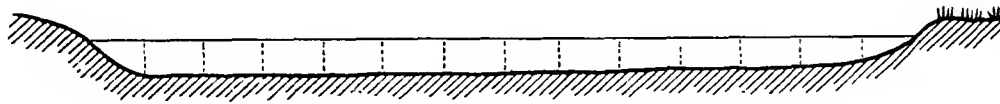


Fig. 147. Right. 1.95 1.87 1.86 1.91 1.88 1.83 1.82 1.77 1.64 1.56 1.49 1.35 1.30 = depth. Left.  
 73 136 167 171 178 181 175 165 163 139 117 88 67 } velocity.  
 108 139 149 166 176 181 160 171 160 144 123 106 72 }  
 113 142 137 150 150 168 140 158 162 137 123 105 64 }  
 Breadth = 42.60 m. Tarim at Kirtschin, May 7. Scale 1 : 400.

All the morning and noon of the 23rd May there was a strong east wind, but in the afternoon it veered round to the south-west. When we passed up-stream on the 7th May we also had an east wind just here, and great was the help it gave the men paddling against the stream, although they did indeed avoid the middle of the current and kept their canoes as far as possible to the smooth water over the alluvial deposits. During the night of the 6—7th May the river dropped 3.1 cm. On 7th May I took the following measurements immediately below the Kirtschin-arm — breadth of river 42.60 m.; mean depth, 1.588 m.; mean velocity, 1.3167 m.; volume, 89.06 cub.m. in the second. At the same place I again took measurements on the 23rd May, with the following results — breadth, 42.30 m.; mean depth, 1.328 m.; mean velocity, 1.3990 m.; volume, 78.58 cub.m. in the second. These two series of results admit of being compared together all the more readily, because on both occasions

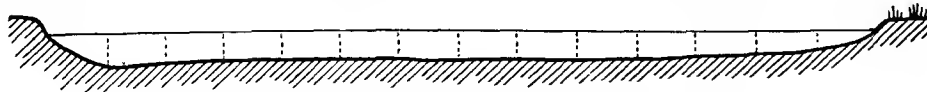


Fig. 148. Right. 1.73 1.55 1.57 1.59 1.59 1.58 1.54 1.47 1.37 1.32 1.21 1.10 0.97 = depth. Left.  
 76 136 166 189 178 190 181 182 180 162 140 108 84 } velocity.  
 100 142 165 186 179 183 181 185 158 146 159 94 86 }  
 100 124 158 158 168 160 169 161 153 151 136 119 82 }  
 Breadth = 42.30 m. The same place, May 23. Scale 1 : 400.

the graduated (3 m. distances) rope was fastened to precisely the same poles, set up one on each bank. The reason why, notwithstanding so great a drop as  $10^{1/2}$  cub.m., the breadth only diminished by 0.3 m., is that the scarped banks just there are virtually vertical. The fact of the mean velocity of the current being a few cm. more at the latter date, in spite of the decrease in the volume, may have been due to a more rapid evaporation in the lakes lower down, induced by the greater heat of the season, or to a fortuitous coincident augmentation of the contributories higher up the river. Colour is lent to the latter supposition by our finding at Jangi-köl on 16th May a volume of 66.03 cub.m., or 12.5 cub.m. less than at Kirtschin seven days later, and this in spite of the heavy contributions that were levied upon the stream in the interval between these two points. On the 7th May the volume amounted to 23 cub.m. more than it did on the 16th May, as indeed we should naturally expect, for, as we have already seen, the *mus-suji* or main body of the flood caused by the melting of the ice, had passed as early as the middle of March. After that the level drops, at first with exceeding slowness, but more rapidly as the season advances. Instead of a steady drop, as we should expect, between the 16th and 23rd May, we have on the contrary a rise of 12.5 cub.m., and that at a period of the year when we should least of all expect it. One might perhaps explain the occurrence as due, say, to the opportune arrival of the spring freshets of the Ugen-darja, were it not impossible for the melted snows of the headwaters region to have reached Kirtschin so early. The explanation is to be sought in another direction, and I think I may claim to have discovered it.

In the preceding pages I have enumerated a whole series of marginal lakes, increasing in number as we advanced down the river. During the winter these are cut off from the stream, and they dwindle in area, not so much because of evaporation as from absorption into the ground. The ice in the lakes melts later than the ice in the river; nevertheless when the great spring freshets (*mus-suji*) come pouring down, these naturally find their way into the marginal basins, and so great is the total volume of these freshets that, in spite of the drain thus made upon them, the river continues to rise, and pours itself into the lakes, until their levels equal its own. When that equilibrium is brought to pass, the entire body of the spring flood rolls on undiminished down the main channel. Then the river begins to drop, and as it does so, the marginal lakes begin to send back to it through their several canals the overflow water which it recently contributed to them. In this way the level of the river again rises, though it is only for one or two days that the rise is perceptible; for the fluctuation is speedily swallowed up in the general fall, which at this season characterises the river, and which goes on until it reaches its lowest summer ebb.

Here I must call attention to a circumstance which will be discussed at greater length lower down. When on 7th May the volume of the river amounted to 89.06 cub.m., about 1.5 cub.m. of this issued from the Ullugh-köl; on 23rd May the Tarim carried 78.58 cub.m.; and on the 21st a current of 6.667 cub.m. flowed into the Ullugh-köl. If however we disregard the effect of this little lake, that is to say, if we take the measurements above its canal, the volumes on the 7th and the 23rd May respectively would have been 87.56 and 85.18 cub.m., or a difference of only 2.4 cub.m., instead of 10.5 cub.m. Seeing then that this was the effect of *one* lake

alone, we may infer how immense is the influence which *all* the lakes together exercise upon the volume of the river. The action of the Ullugh-köl may possibly appear to be to some extent in conflict with the argument which has been set forth above. If at a given point of time in the spring all the marginal lakes are full, and the river is already dropping steadily lower, the water ought of course soon to flow back into the river; whereas we find, on the contrary, a strong current running *into* the Ullugh-köl. But, rightly considered, this is precisely a proof of the correctness of my reasoning. In the first place, it must be borne in mind that the loss of water in these marginal lakes, which, like the Ullugh-köl, are situated amongst the sand, is enormous, and that their evaporation increases as the summer advances. The accompanying sketch will enable us to see the facts in the proper connections. If, say, the Tarim measures above a given number of lakes A, B, C, D, E, and F 100 cub.m. in the second, and if each of these lakes requires to be fed at the rate of 5 cub.m. in the second, in order that their several levels may coincide with the level of the river, then the river, by the time it reaches the inflow canal of lake G, will have dropped to 70 cub.m. Suppose now that all these lakes down to and including F are full, so that they no longer exercise any drain upon the river, this last, when it reaches the canal of lake G, will be once more running 100 cub.m. strong. The consequence is that the inflow into lake G is livelier than before. The longer the upper lakes are in filling, the later does the river rise in spring over against lake G. As a matter of fact, the outflow and equilibrium of level are established between the river and each lake in turn, and owing to the immense length of the river no serious disturbance results. If however it should happen that several lakes fill simultaneously, the effect would make itself felt to a very marked degree lower down the river. So far as I was able to ascertain, something of the kind appeared to have indeed taken place between the 16th and the 23rd May, the consequence of which was an otherwise inexplicable rise of 12.5 cub.m. in the level of the river.

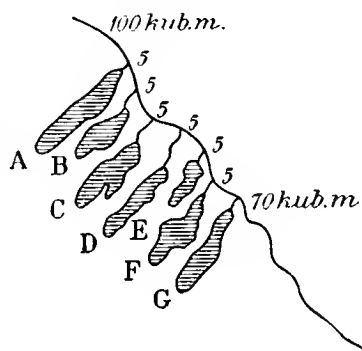


Fig. 149.

May 24th. At Junus-ottogho and Kosch-kotan, immediately below Boba-uktusu, yet another old river-bed with reedy margins leads off to the right of the existing channel; but, except for a mere trickle of water in its deepest part, it was on 6th May quite dry and bare. Although the main current began to leave this bed about 6 years ago, it is only two or three years since that it finally made up its mind to give the definitive preference to the existing channel. That is to say, the river was here for the space of three or four years split into two arms; and the stretch between Kosch-kotan and Tarim-kirdi is consequently without forest. Indeed there appears to be no forest beside the southern, abandoned arm either — a significant fact, proving that the river must previously have pursued a more northerly course. On the left bank stands the village of Tuvekteki-uj, inhabited thirty years ago; perhaps even as early as that some little rivulet groped its way towards the present channel. At the sharp bend of Tarim-kirdi stands the village of Tägirmändake-uj, consisting of four huts; this was inhabited in 1898, but not in 1900. In fact, the



villages in this part of the country are as changeable as the river-bed itself. The village just named was abandoned in consequence of its being threatened by inundation, and because it was cut off from the country behind by temporary marshes and lakes. When this happens, the inhabitants prefer to flit their Penates to a place of greater safety; and though they carry away all their movable property with them, such as their implements, instruments, fishing-nets, and so forth, they leave their huts behind, partly because the materials of which they are built are valueless, consisting as they do of nothing but poles, branches of trees, and reeds, and partly because they imagine it would be convenient to have the old huts to return to in case the river should once more shift its channel.

The river-bed bears in this locality the most unmistakable evidences of being a quite recent creation. It is practically an overflow current which is actively engaged in excavating its own channel by erosion. Sedimentary deposits, with young reeds just springing up on them, stretch in every direction. The velocity of the current is as much as 1.2 to 1.4 m. in the second; and as one watches it one can see how it successfully accomplishes its purpose step by step. Under the convex banks, where the current is slowest, the sedimentary matter is being deposited in crescentic belts. On the other hand the concave parts of the opposite banks are being subjected to a vigorous assault. These processes are illustrated in the accompanying fig. 150. The final result is the well scarped and distinct river-bed with which we have become so familiar. The irregularities which show themselves in the development of the river-bed, whereby some windings become much deeper and longer than others, are in this flat and uniform region due to positively trivial causes, such as tamarisks binding the ground together with their roots, the presence of a reed-bed, and so forth. For some distance there lies here, north of the existing river, an arm which was deserted only a year ago.

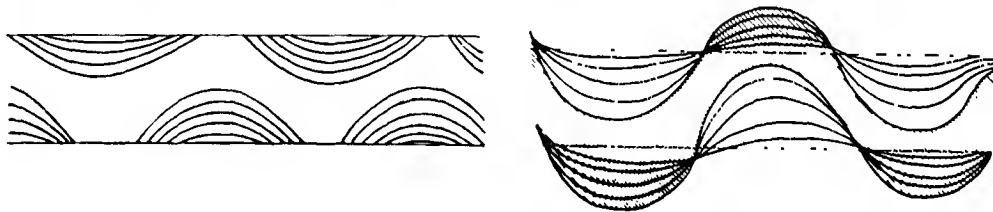


Fig. 150.

The main river now crosses what six years ago was the lake of Lolo Kullunu-uktasi, but is now completely filled up by its sediment; and the village of Tschulum Kulluden-ot-kätkän, on its left bank, has been deserted for the same reason as the village I last mentioned. Here there are both living and dead poplars standing in the middle of the river, a sure indication of the country having been quite recently put under water. On the right bank lies the lake of Uktasi, with the homestead of Uktudeki-uj; the former is fed by a canal (*atscha*) from the river. A portion of its water returns to the river at Scharkurun (Cataract Arm), while another portion (about which I have more to say later on) makes its way into the old bed of the Tarim and the Katik-arik. South of Uktasi lies amongst the sand the lake of Talashti, equalling in area the Ullugh-köl.

## CHAPTER XIII.

### THE INTRICATE NETWORK BETWEEN KEPEK-UJ AND AJAGH-ARGHAN.

The river again divides at the deserted village of Kepek-uj, the empty huts of which are still standing. The arm which goes to the left will be described in another part of this work. Its upper end was on 6th May expanded into a veritable basin, thickly studded with mud-banks and alluvial deposits more or less overgrown with reeds. Here forest is again pretty common. Thus at Kepek-uj the river is deprived of a considerable portion of its volume. On 24th May the Kalmak-ottogho arm was a good deal narrower than it had been on the 6th, though it was still a noble stream, and it is not at all unlikely that the principal river is actually contemplating a shift into that same arm. Leaving it however on one side, we glided through an extremely narrow channel into the reed-grown lakes of Kurban-dschajiri and Süsük-köl. In these small lakes the river lets drop the sediment that it carries with it; the greatest depths we obtained in them were not more than 2.25, 1.38, and 1.42 m. Consequently the stream which flows out of them, through another narrow canal to the south, is perfectly transparent. On each side of this latter canal, through which we experienced the utmost difficulty in forcing our ferry-boat, the new green reeds of that year stood four meters high and were crowded together in masses of unexampled density. It was like threading our way through some watery corridor, with solid walls on both sides of us. Indeed in some places it was absolutely necessary to set fire to the dry yellow reeds of the previous year in order to see where we were going to, and to get an idea of the ins and outs of this remarkably intricate labyrinth of reeds. After that we proceeded east-north-east across the lake of Tuvadaku-köl, where I measured depths of 4.05, 4.85, 2.10, 2.30, and 3.0 m. From this lake we passed into the Balik-kumgütsch-köl, where an older hut, Muhamed-uji, was demolished the year before. Finally we crossed the lake of Jäkänlik-köl to the village of Jäkänlik, the four huts of which we found still occupied by two families, each consisting of 5 persons. The greatest depth I measured here was 1.73 m. South-east of Jäkänlik stretches the lake of Äger Kullune-köli; and south of it the large desert lake of Begelik-köl, to which on 25th May we made an excursion. This lake is described elsewhere.

Some parts of the Tarim which we traversed after leaving Bulung-su, are said to have been formed about sixteen years ago. Previous to that the river had for a long period — my informants thought it was fully fifty years — followed its old bed along the edge of the desert. Previous to that, again, it must have flowed along the same path it now pursues. That is to say, it oscillates backwards and forwards from the one bed to the other. On the whole I do not doubt but that these statements are in agreement with the real facts. That the river is very undecided and unstable is sufficiently proved by the presence of its marginal lakes; for they too are extremely transitory and inconstant, and speedily fill with mud, dust, and decaying vegetation.

May 27th. We left the Jäkänlik-köl by an arm issuing from the lake which was embedded amongst the thick reeds and carried a deep and limpid stream. Passing on the left Markat or Markatdake-kona-uj and on the right Schah Niasikadasi, we again entered a chain of lakes and marshes, with the hut of Ghapan-uji on the left. In an expansion at Markat I measured successively depths of 14.0, 11.85, and 10.25 m. This depth 14.0 m. is the very greatest that I sounded anywhere in the Lop region, and more than twice as great as the deepest sounding that I obtained in the Kara-koschun, the extensive terminal basin of the entire Tarim system. This depression is probably a trench, which has some time or other been hollowed out by the wind and has never subsequently been filled up by sedimentation. On the right we left the lake of Selimi-tschojogho-köl, and beyond it appeared firm ground with an occasional poplar; and still farther away the Katik-arik arm, which supplies Begelik-köl with water, enters the old bed of the Tarim. We were here farther from the high sand than we had been before, and it was only occasionally that we caught glimpses of it, as for instance on the nearer side of the Ku-tutu-köl. Beyond the large island of Avul-akmasi there appeared wide reed-grown expanses of water. Owing to the height of the reeds it was difficult to see how big the lakes were. All that could be mapped with certainty was the actual route of the ferry-boat and the situation of the endless beds of reeds, some near at hand, others farther away, which shut in the view to right and to left. We reached the Geremdake-köl through the Ismaile-arighi. Beyond an island of firm ground, that is to the north of our route, stretched the lake of Avul Nias Bekne-kölughu. Then came on both sides several islands of firm sedimentary matter, overgrown with vegetation, or rather pieces of almost primeval soil; this was especially the case at Schidakmähalläsi, where there was also a flourishing and shady poplar grove. Here it was plain that the river was endeavouring to expand its channel by filling the lake. The depth was everywhere slight, generally not more than 1 m. But upon our waterway widening out in the lake of Ghilange-kölu, the depth increased to 3.82 m. and 7.20 m. On the south shore of this lake stands the homestead of Ghilangdake-uj, which was inhabited about forty years ago. All this time there was a current, though in the lakes it was extremely sluggish, often indeed imperceptible. In places the reeds formed thick green clumps like islands, with patches of white water-lilies swimming amongst them. I was assured, that if I were to travel north from this point, I should only cross two watercourses, namely the Ara-tarim and the Ilek of the Kontsche-darja; consequently there could not be any intricate network of canals in

that direction. At the point where we turned to the south-west the Jaka-atscha leaves the river eastwards for Ak-dung, situated just above the *baschi* or »head» of the Laschin-darja. Jaka-atscha, which means the »last», or »the outermost», channel is however no longer applicable, for there is now yet another canal, which has perhaps been formed since the Jaka-atscha was given its name. Next comes, on the right, Joldaschte-uj, uninhabited. It was indeed surprising to find all the huts we saw empty; for all the way our ferry-boat was surrounded by a crowd of canoes. They came from the newly built huts on the other side of the reeds, which we could not see. On our right we had firm ground, with poplars, small tamarisk-mounds, and sand-ridges clothed with vegetation; often too the dense reeds hid firm ground, which consequently we could not always see. The stream carried us out of the lake into another reedy channel, which soon divided, the left branch going to Ak-dung. We however followed the right branch. Immediately below Ak-dung begins the Laschin-darja, a powerful stream (see below) formed by the union of several emissaries from the lakes I have been speaking about, and entering, as I have said, the Ara-tarim. On the left comes the homestead of Adok-uj, and then, but a little way back, Ojman-köl-kischdake-uj, or the »Winter Domicile of the Deep Lake», the people of which are now settled at Tikenlik. Then we entered the Otak-köl, which winds like a broad river-arm; it was tolerably shallow and the water perfectly transparent, so that we were able to see all the details at its bottom. To the south-west we perceived the patch of sand which marks the entrance to the lower Baschtage-köl. Beyond Otak-köl the river contracts to a narrow channel with broken water (Scharkurun), pointing to the existence of a ridge or »threshold» across the bottom. Here we had to steady our ferry-boat by ropes from both banks. Finally she again glided out upon the Tarim, at a point where we once more perceived the old bed which begins at Bulung-su, and which for a great part of its course forms a channel for the Katik-arik. The volume of this last was here 2 to 3 cub.m., the stream keeping close to the scarped right bank. The old bed was however filled with silt and sand, this being virtually the cause of its having deserted that channel. Although the quantity of water which now flows down it is insignificant, this old river-bed shows that formerly it was traversed by a stream of some magnitude. The greater part of the water of the Tarim goes into the Laschin-darja. Another arm, now dry, goes to Putalik-köl, just above the village of Ojman-köl, inhabited by five families or 40 individuals, and thence proceeds to the Ojman-köl. The cultivated ground of the village is watered by a smaller arik, which leaves the Tarim lower down. The bottom of several of these ariks lay at that time a good meter higher than the river, and even at the period of high flood they get little or no water in them owing to the strong inclination which the river manifests to pour itself wholly into the bed of the Laschin-darja, and so destroy the channel which we were then navigating. For the same reason the former lake of Iskatka Värđi-köl has completely dried up; and the same thing is true of the Kara-tschege-köl, a lake surrounded by small dunes, bearing tamarisk bushes. A dry arik goes off to the former grazing-grounds of Menglighi-tschakmaka-kalghan. The river then becomes very winding, the bends being short and abrupt, and the alluvial desposits to a greater extent exposed. There was a little scanty forest, the trees being quite young

and thinly planted. Embedded in the sand are the two lakes of K  k-k  l and Baschtage-k  l, both reported to contain fresh water, although now both cut off from the river. When the existing channel becomes dry, as it seems likely to do, and the stream flows through the Laschin-darja, these desert lakes will entirely disappear and no longer levy any contribution upon the river. This would of course mean, *ceteris paribus*, an augmentation of the inflow into the Kara-koschun. In 1898 the K  k-k  l was still connected with the Tarim, but the connection was cut off in the summer of that year. Naser Bek, a man of sixty, told me that the Tarim, after having for many years flowed along the channel in which we then were — it did so in the time of Naser Bek's father — had become diverted into the Laschin-darja three years before our visit. Previous to the lifetime of his father the Laschin-darja was the principal artery of the Tarim system. Thus we have here again two channels between which the river alternates periodically. As soon as one of these two becomes sufficiently raised by the deposition of sedimentary deposits and the growth of material along its banks, the water seeks its way through the other.

May 28th. Measuring the river in the morning, I obtained the following *data*: breadth, 22.66 m.; mean depth, 0.999 m.; mean velocity, 0.5839 m.; and volume, 13.22 cub.m. in the second. And for the last three years the principal trench of the Tarim has here been no bigger, because in the same years the Laschin-darja has been growing. Only five days previously we found that the volume of the Tarim amounted to 78.38 cub.m. in the second. Hence there was here a loss of 65.4 cub.m. With regard to the future direction and distribution of the volume that is thus lost, see a subsequent chapter; though I may add here, that it goes in part to the Ara-tarim, and also, more particularly, in the form of canals issuing from the lakes described above, to Ak-dung and Laschin. Down to the point we have now reached the Tarim has a continuous flow all the year round, although its channel is constantly contracting; no doubt it will eventually become entirely obsolete as soon as these lakes have become dammed up with sedimentary matter. At the spot where we took our measurements the high-water line was 1.58 m. above the existing level, an indication that the area of a vertical section of the river had lately been more than twice the area of the actually existing section. At that time the *datum* was 22.63 sq.m., whereas at the high-water season it had been 56.17 sq.m. I have no doubt that these high-water lines were left in previous years; it is very problematical whether the *mus-suji* had risen so high that year.

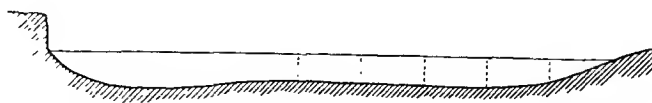


Fig. 151. Right. 

1.31	1.38	1.19	1.02	1.07	1.07	1.08	0.87
70	81	71	69	75	66	63	42
63	75	64	61	79	60	65	60
59	53	46	55	66	51	50	50

 = depth. Left.   
 } velocity.   
 Breadth = 22.66 m. Old Tarim, May 28. Scale 1 : 300.

During the day we noticed how great the resemblance is between the Tarim here and the Jarkent-darja above its confluence with the Ak-su-darja: that is to say, it is sinuous, its current excessively sluggish, and its bed sharply cut. As

compared with the Laschin-darja and the Ara-tarim, it appeared to be wanting in energy, as well as to be dwindling. The more noteworthy points are these: — Ajtungu-sörutmasi, a loop with a rather narrow neck or »stalk». The word *sörutmasi* is equivalent to *kötörmesu*, and means a »portage»; but in this particular case the loop is so short and the portage so wide, that the expediency of hauling canoes across it is more than doubtful. At the base of the loop the sandy desert once more approaches the right bank. On the left bank is an overgrown sand-hill, with a solitary poplar, known as Jileg-uj. This day the river-banks were all along tolerably well equipped with poplars of a riper age. On the same side of the river two dry ariks lead off to a vanished village. Then on the right comes Äger-asti, and, again on the left, Schah Mansurne-osasene-basch-tam-arighi, which long name means the Canal of the Cultivated Land around Schah Mansur's Upper Clay House. Next, still on the left, we have Tajir Achune-kotane, and, farther on, the village of Kuslek or Schah Mansurne-uj, long uninhabited. On the right we note a dry *atscha*, leading to the lake of Ettek-köl amongst the sand; but having received no fresh accession of water, it has become converted into a *daschi* or »salt pool». At Asimet Beki-uj, on the right bank, there are low sand-dunes clothed with vegetation. Behind these, and between them and the high barren sand, lies the desiccated lake of Schikak-köl, connected with the river by the dry canal of Schikak.

The river is now seldom as much as 5 m. deep. We measured the depth in the middle of the stream, taking soundings once every minute for the space of an hour after leaving Asimet Beki-uj. The maximum depth was 4.80 m., obtained in three separate soundings.

On the morning of the 29th May the Adoke-kok-alasi, which comes from the Laschin-darja, had the following dimensions: breadth, 12.0 m.; mean depth, 0.900 m.; mean velocity, 0.6648 m.; and volume, 7.18 cub.m. in the second. Thus from this point the river receives a not inconsiderable augmentation. Some years ago the Adoke-kok-alasi was the principal channel of the Tarim, that is at the time when it was beginning to desert the river-bed which we last navigated. Four years before it is said to have been still a very powerful stream, but three years ago, when the Laschin-darja was formed, it began to decrease, until now its volume was barely 7 cub.m., as compared with 13 cub.m. in the old river-bed. On the left is a strip of low dunes, with vegetation; a large poplar amongst them bears the name of Kamschuk-tüschken-toghrak. From the right a canal, now dry, leads off to the Jangi-sudake-köl, situated amongst the sand-dunes. Then comes, on the same side, the masar of Istam Begi-markati, with the graves of the beks who used to live at Jangi-su. Immediately beyond that stands a cluster of huts, Jangi-sudake-kona-uj, which were deserted six years ago in consequence of an outbreak of small-pox, the people flitting over to the left bank and building a new Jangi-su some distance lower down. This village was said to number 22 families; while 18 other families from the older Jangi-su had settled at Mandschar-baschi beside the Tschivilik-köl. Supa Bek, the bek of Jangi-su, told me, that he had altogether 498 people subject to his authority. Opposite to the new Jangi-su, on the other side of the Tarim, there is a *boldschemal*, or now destroyed loop, of the river. The name of Jantak-alghutsch-

osasi-arighi is given to the country around a small isolated patch of sand on the left bank. The next desert lake, but at a considerable distance back from the river, is Godsche-tutghutsch-köl, with a large, but empty, canal; the water in the lake is salt. Finally, there are several dry canals on both sides of the river; and, on the left, Murat Kasini-putalikini-uji and Alvandake-ujne-arik.

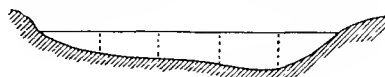


Fig. 152.

0.84	1.02	1.24	1.40	= depth.
69	82	112	60	} velocity.
24	84	120	32	
10	89	129	30	

Breadth = 12.0 m. Adoke-kok-alasi, May 29. Scale 1 : 300.

May 30th. First we passed on the left a canal which at one time turned a mill, as well as supplied the now unoccupied huts of Jachijani-uji. On both sides there were small patches of sand, though fewer on the left than on the right. But, although there were tamarisks and other bushes growing on conical mounds of earth and sand, and single poplars, there was no forest. At the village of Kurbane-uji a canal goes off on the right to the lake of Kotschkatsch-köl, situated amongst the desert sand, and, its level having fallen with the river, still receiving water from the latter. The three families of this village, counting eleven persons in all, used to live principally upon fish caught in the Kotschkatsch-köl; they are subject to the bek of Jangi-su, and are enumerated amongst the 498 persons already alluded to. After passing two or three short, but abrupt, bends, we came to Jan Kulligha Värigen-tarim on the left bank, a channel which dried up forty years ago, and upon which previous to that time the Kamschuks are said to have sailed their boats. Lower down it joins the newer bed, by which we continued to drift. On the right lies, close to the river, and this side of the sand, the lake of Asimetgha Värigen-köl, tolerably small, and divided into two basins; it is reported to be comparatively deep, and is fed from the river when the latter is high. As a rule the high sand is masked by the reeds, new and old, which line the banks.



Fig. 153. ONE OF THE TSCHAPGHANS IN THE NEIGHBOURHOOD OF SCHUKURNE-KOLI.

Soon after this we came to another important bifurcation, a large portion of the stream deviating through the adjacent oblong lake of Bos-köl, and leaving it at its lower end by a channel which soon enters the main river. Seven years ago the whole of the Tarim flowed that way with an undivided volume. The reason of the river having here changed its course is that a man named Assan, at the period indicated, dug

a canal from the left bank, and this widened the stream until finally the entire current precipitated itself through it. A small, and wholly artificial, cause for such a great effect! The new arm is therefore called Assan-tschapghan-tarim. Nevertheless a portion of the stream still continues to find its way into the Bos-köl. A little farther down another arm, the Oghu Dschanghu Värđi-tarim, leads off from the left to the now dry lake of Chodai Värđi-uktusu, but rejoins our Tarim at Kaken-dijni-dschaji. In this locality the river manifests a certain tendency to flit to the left; it is almost as though it had covered the country on the right with alluvial deposits and were now seeking a passage at a lower level on the left, that is to the east, where indeed it used to flow formerly, and that perhaps at several different epochs. After that we passed the lower and larger outflow canal of Bos-köl (the upper one is now empty), and then, on the left, a shorter arm of the Tarim three years old, which empties itself into the Kaken-dijni-dschaji. Beyond that the river divides, the right arm being the larger, though both arms enter the lake of Schukurne-köli. Here the river is again very uncertain as to its path, violent, divided, and of no great depth, forming shallow, reed-grown lagoons, which, strictly speaking, are nothing but expansions of its bed. The lake of Schukurne is said to be an extensive sheet of water, and even to penetrate some distance into the desert. That is to say, it is in part a desert lake and in part a reedy lagoon, and consequently belongs to both the types of lake which we are discussing. We next crossed the shallow, reed-grown lake of Talashti-köl, and then the lake of Sattovaldi-köl, this latter with a large sandy island, Sattovaldi-kijik-atghan-dschaji.

On 31st May we found ourselves, soon after starting, in a shallow, contracted, winding *ilek*, or »channel», which empties itself into the lake of Taltikti-köli, the main portion of which we left on our right, surrounded by low sand and tamarisk-mounds. The waterway was thickly beset with kamisch, rushes, and water-lilies; it took us south-east to the Jäkänlik-dschaji. On both sides there were small patches of sand, partly separated, partly covered by the recently arrived water. Finally we emerged from this intricate and stifling watery passage into the large lake of Nias Bekni-köli, called also Attamne-köli and Nias Bekni Attamne-köli. Like the lakes in the desert, this extensive sheet of water is for the most part open and free from reeds, and encompassed by low sand held together by vegetation. But while the desert lakes extend from the north-north-east to the south-south-west, these Tarim lakes stretch from the north-west to the south-east. The position of the former has been determined by the wind; but in this part of the delta of the Tarim, where the entire surface has been levelled and flattened out by the sedimentation of the water, the wind possesses no power, at all events in this respect. In general these Tarim lakes are of the same depth as the river itself. The greatest depths we obtained, for example, in the lake of Nias Bek amounted to 3.63 and 4.59 m. Thus they no doubt coincide with original depressions in the ground; but their topography and depth render it probably that they stand in some sort of relation



Fig. 154. LAKE BETWEEN THE BANKS OF TWO OLD RIVER-BEDS.



to the river's capacity for depositing sediment. From what is said above we see how ready the Tarim is to shift its bed in this region. Not a year passes without long stretches being destroyed and new channels being formed in their places. The farther we advance, the more restless and capricious grows the stream, and the more numerous become the *kona-darjas* or *eski-tarims* on both sides of the main channel. Here for centuries past the Tarim has been depositing vast quantities of sand, which it has shorn off the edge of the desert and carried down with it in suspension. The reason why the river flings itself out of one bed into another is that it keeps on successively raising their levels. After these oscillations have continued for centuries, the face of the country becomes eventually chequered with a number of more or less parallel swellings or ridges, running north-west and south-east. When an overflow takes place, it is quite easy to see how the space between two of these fluvial ramparts may become filled with water, the result being that the lakes, which are thus formed, inevitably tend to assume the same direction as the river; and this, as we have just seen, is actually the case. Indeed all the depressions in the Lop country exhibit an inconceivable regularity in the matter of having their longer axes disposed from north-east to south-west. In the case of the lakes situated amongst the desert sand on the right of the Tarim, in the case of the Kara-koschun lakes, the dry depressions of the Lop Desert, the *bajirs* of the Desert of Tschertschen — everywhere the same north-east and south-west direction prevails. But the two lake regions we have just traversed, both of them originating directly in the water of the Tarim, have their long axes disposed at right angles to this, or from the north-west to the south-east. Now for this there must of course be a special cause, and this cause is very probably to be found in the river's levelling tendencies, its peculiar property of forming ramparts by means of its sedimentary deposits, and the effects of the riparian vegetation in binding these deposits together. Later on, however, we shall see that the lakes of Avullu-köl, Kara-köl and others must have been formed in exactly the same way as the lakes and bajirs of the Desert of Tschertschen.

The eastern shore of the lake of Nias Bek consists of low connected dunes, with tamarisks growing amongst them on their characteristic cones; amongst these lies the deserted village of Abdul Baki-uji, containing four huts. In the district of Nuruma, beside the Tarim, which is now some distance to the east, the barren sand is said to plunge steeply down into the river; though probably the dunes there are low in elevation. The lake of Kaken-dijni-dschaji lies beside the river, and to the east of it is another lake, the Ullugh-köl, into which there is an inflow at the season of high flood only. On the right of our route, that is to the west, there is said to lie amongst the sand an old bed known as the Tale-jatghan-tarim, now dried up, except that when the Tarim rises exceptionally high, it sends a small stream along this old channel. On the other side of Nias Bek's lake, we were taken by a small *ilek*, in which there was a distinct current, as well as alluvial deposits, into the lake of Örtäng-dschajir. This is quite a small sheet of water, and on its opposite side we again penetrated a narrow, shallow channel fenced in by rushes. In this, as in the final outlet from the previous lake-complex, there were cataracts, though the fall here was certainly not more than 1 or 2 dm. Nor is it at all sur-

prising to find cataracts at the points where this long chain of lakes restore their water to the Tarim. All the lakes lie at the same level, but the river has a gentle fall; consequently the fall in the case of the lakes becomes concentrated at the spot where their outlet seeks the river. And yet this does not apply to the entire series of lakes, because, as we have seen, the various individual sheets of water are connected together by short waterways, in which there are lively currents. In the lakes themselves, too, there is a movement of the water, although it is very gentle; so gentle, in fact, that their surfaces may be taken to be horizontal.

Thus we were once more out on the broad river. It still presented the same appearance that it had done before we entered the lakes-narrow, deep, extremely sluggish, the water very limpid, after having filtered through the reeds and rushes of the lakes. The alluvial deposits were very small and thin. At intervals a solitary poplar. On our left we passed a hut, long ago deserted, and known as Alim Niasi Iliasidake Muhamede-uji. On the same side too is the not inconsiderable marginal lagoon of Putalik-köl; and on the right the district of Muhamede-mutschekan-uji.



Fig. 155. PASSAGE BETWEEN TWO OF THE LAKES.

June 1st. At our camp we obtained the subjoined measurements: — breadth, 33.7 m.; mean depth, 1.114 m.; mean velocity, 0.5728 m. in the second; and volume, 21.50 cub.m. in the second. The last preceding measurement, plus the Adoke-kok-alasi, gave a volume of 20.4 cub.m.

During the day the river described several tiresome little bends, and had a sluggish flow. The barren desert only approached it at a single point. The Putalik-köl, on the left, soon came to an end, issuing by a broad and imposing *kok-ala*, or channel, into the river. But the water in the channel was clear and stationary,

and the actual inflow into the river was *nil*. The lower reaches of the Putalik-köl are crowded with water-lilies, which are gathered by men from Turfan, to be used as a remedy against fever.\* Four years previously a very considerable quantity of the water of the Tarim used to flow through the Putalik-köl and its kok-ala, and this was the route always chosen by canoes, especially when paddling up-stream, for in this way they were able to avoid the adverse current. But in proportion as the Laschin-darja increased, so did this Putalik-köl arm decrease. On the left we passed three small canals, which only as late as the previous autumn supplied water to the wheat-fields of Tinatschini-kölidake-osasi, lying opposite to Basch-arghan. At the time we passed, the ends of these canals stood 1 m. above the level of the river, but it was hoped that the autumn flood would rise sufficiently high to renew their supply. On the same side of the river we noted a dune, with vegetation, known as Muhamede-karaul-dung, and opposite to it on the right bank a deserted hut bearing the same name. Poplar woods are again quite common, especially on the right bank; the trees, which are handsome and of good maturity, are mingled with tamarisks and grow amongst low connected dunes. There is an abundance of dead wood and broken branches littering the ground. On the right we have Muhamede-godsche-

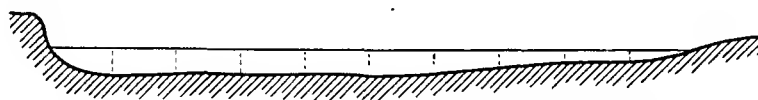


Fig. 156. Left. 

1.53	1.42	1.43	1.50	1.49	1.30	1.02	0.75	0.70
31	70	79	68	68	62	63	58	45
56	62	80	71	72	52	49	49	29
58	70	64	90	70	55	51		
55	71	68	68	65				

 = depth. Right.  
} velocity.  
 Breadth = 33.7 m. Old Tarim, June 1. Scale 1 : 400.

tutghutshtake-uji, and a *boldschemal* containing a semi-crescentic pool. It is in this abandoned loop that the old bed of the day before, the Tale-jatghan-tarim, rejoins the main stream. The natives declare, that there is still an occasional pool to be found in it. In the desert, south-east from this point, lies the lake of Baschtage-köl, which is said to be as large as the Begelik-köl, and to consist of three basins, — the Aghis-köl, the Tughadake-köl, and the Tschapghan-köl. The channel which connects this lake with the river enters the latter just below a sharp S-shaped bend. From this point the loops become much longer. Next, on the right, a masar crowning a hill, and on the left Solomadake-dung. The belt of sand on the right of the river is called Arghamtschi-baghladi-kum. At Basch-arghan we have the termination of the dry Tarim bed, the Ettek-tarim (see below). After that the river contracts tremendously, at the same time quickening its velocity; the alluvial deposits are very few, and steep; and the banks vertical and high. In fact, the river resembles a canal. Sand-hills and tamarisk-mounds are common on both banks, and poplar woods are general, especially on the right bank.

\* The water-lily is called *podolik*. *Putalik* is the word for a dense tamarisk forest. The word which forms the lake's name is evidently *podolik*, although it is *de facto* pronounced as I have written it.

June 2nd. The progress of our ferry-boat was a good deal hampered by a stiff gale blowing from N. 60° E., the river happening to run precisely in that direction. The tract immediately below our camp was called Tinatschini-kötörmesu; it possessed an old arik. From the right proceeded a large canal, as usual dry, leading to the similarly dry lake of Ettek-köl; this was formerly a *bajir*, or »desert depression», which subsequently became filled by the river. But after the latter began to dwindle, the supply diminished, and the lake dried up. About twelve years ago attempts were made to secure a recurrence of the flow by deepening the shallower parts of the canal, but they ended in failure. This lake, then, affords an example of the fate that will overtake all these desert lakes as soon as the river ceases to flow in proximity to them.

The Tarim still retained the same character as before; that is to say, it was narrow, deep, and sluggish. All day forest of respectable dimensions was quite common, alternating with connected sand-dunes and dense tamarisk thickets, whilst the banks were everywhere fringed with reeds. After that several ariks, then dry, leave the right bank for the lake of Al-katik-köl, which is likewise dry and its bed converted in part into wheat-fields. The lake-bed turns to the east, and sends off an outflow canal to unite with the Tarim at Arghamtschi-baghladi. Beyond that the river runs for a good distance towards the north-east without any troublesome loops. On the left is a *boldschemal*, containing a pool called Jilgha-köl. We made our camp at Ajagh-arghan or Arghan, just below the station-house on the great caravan-road. This the Musulmans call by the Chinese name of *gen-deng*. Arghan is the Ajrilghan of Prschevalskij; the word *arghan* being a convenient abbreviation in daily use for *ajrilghan*, which means the point of bifurcation of a river or a road. As a matter of fact several river-arms unite at this particular spot, although to one paddling up-stream they do divide. Originally the name was quite justified also to one rowing down-stream, for Arghan lay formerly at the point where the Tarim divides into the Ettek-tarim and the Tschong-tarim. Of these the former is now dry, the latter carrying the whole of the volume. After the Ettek-tarim dried up, the name Arghan was transferred to the existing point of confluence; and the two Arghans are distinguished by calling the older one Basch-arghan or Upper Arghan, and the other Ajagh-arghan or Lower Arghan. This day we again measured the depth of the river at intervals of a minute during the space of a full hour, and obtained a maximum sounding of 4.98 m. In the active streams, which contain a large volume and deposit much alluvium, we get no such depths as this. In point of fact, this part of the Tarim resembles the Ugen-darja, in that both are deep and narrow, and without alluvial deposits, and their volumes of water are quite insignificant, but on the contrary both have a very considerable size of riverbed, though the current is extremely slow. The water was unusually clear. Thus here again, in this moribund arm of the Tarim, we have merely the deeper trench surviving from what was once a much more imposing stream.

Ajagh-arghan was one of my most important centres in the Lop country, and here we accordingly rested a day or two whilst I carried out certain measurements in the river. On 3rd June a *sarik-buran* blew from the east with a velocity of 9 m. in the second, but the wind soon veered round to the east-north-east, the pre-

vailing direction of the wind throughout the whole country. I was repeatedly assured, that the violence of the wind abates in the beginning of the summer, and that the warmest months of the year are generally very still and calm. At noon I made a little trip in a canoe to the Jätim-tarim and the arm which issues from the Tschivilik-köl. After paddling 38 minutes north-west above Ajagh-arghan, we reached the confluence of these two rivers; their united currents made a stream considerably larger than that on which we had hitherto been travelling. About eleven years ago a *boldschemal* was left on the right of the united stream; it still contains an almost ring-shaped pool, separated from the river by merely a narrow isthmus. It bears the name of Paschalik-otak, or the Gnat Place, apparently a very suitable name, for no sooner did the wind drop than the air literally swarmed with mosquitoes and gnats, which, in conjunction with the *kökön* or »gad-flies», whose, sting burns like fire, plagued us horribly.

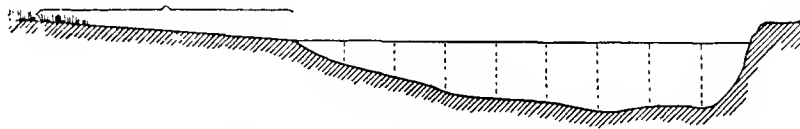
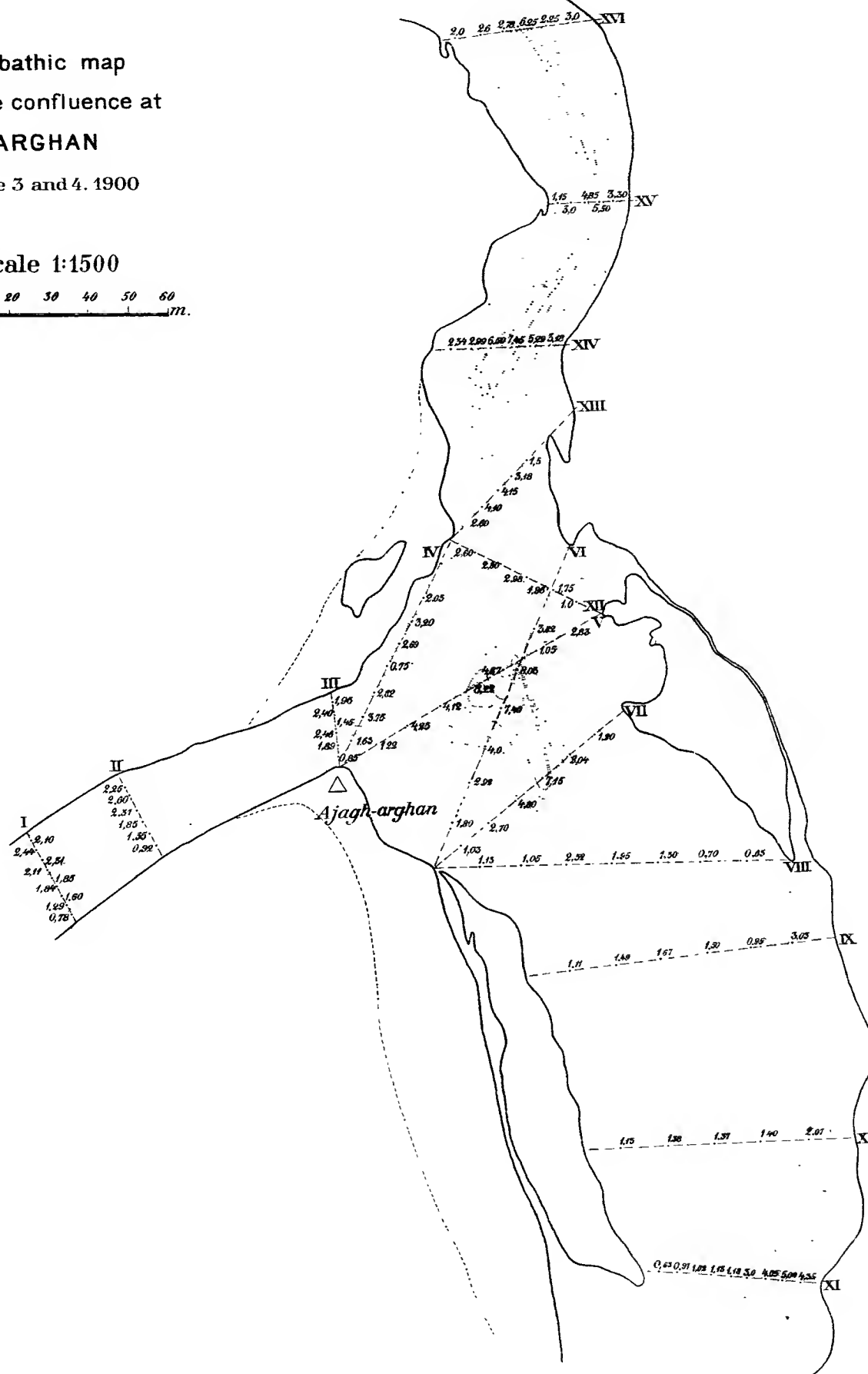
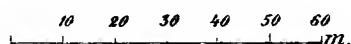


Fig. 157. Right. 0.98 1.46 2.03 2.26 2.38 2.76 2.53 2.58 = depth. Left.  
 38 58 67 78 81 78 52 47  
 29 60 77 81 73 72 75 70  
       77 78 78 76 68 63  
           71 69 74 74 71 } velocity.

Breadth = 18.00; breadth of dry alluvium on the right side = 10.2 m. Jemischek-kok-alasi, June 3.  
 Scale 1 : 300.

From the confluence we proceeded north-westwards up the Tschivilik-köl arm. This too is a double-branched stream, for it has another branch to the east, called Tschaptschimal-kok-alasi, which also comes from the Tschivilik-köl, though at Schejtlar (see below) it leaves its sister stream and goes its own way. During the recent *mus-suji* it was said to have carried a respectable current, but it only lasted a month; now however its stream was quite thin and stationary, though occasionally in the expansions it widened out to a spacious basin. The last lake it passed through was the Ghodajlik-köl. From the same lake issues the Tschivilik arm, the real name of which is the Jemischek-kok-alasi; below the lake just mentioned it forms the lake of Asane-utturghan-köli. Above the Ghodajlik-köl stand Supa-dughan-uji, uninhabited, and Tämir Niasne-uji or Schejtlar.

After this we rowed a short way up the Jätim-tarim, the Fatherless and Motherless River. Along it, going up-stream, I noted the following names — Tughane-ölöghu-jatghan, Tala-tschorak, Saj-tokkan, Talipi-egrimi, Jughan-tapup-aldi, Katschkene-jarsighi, Ak-jaghatsch, Karaune, Tschajlik, and Kara-daj. Everywhere, so far as we threaded them, these fluvial bye-ways were bordered by plenteous woods in places even quite dense and luxuriant, matted together with thickets, bushes, and fallen branches. Thus the Tschaptschimal and Jemischek-kok-alasi unite to form a short stream which possesses no name. In this last I obtained the following measurements — breadth, 18.0 m.; mean depth, 1.887 m.; mean velocity, 0.6359 m.; volume, 21.60 cub.m. in the second, or rather more than in the arm of the Tarim which our maps depict as the main stream of the system. Indeed, the latter has within recent





years been quite surpassed in this respect by some of its »secondary» branches. The transparency here, notwithstanding the vigorous current, was no less than 60 cm., a sure proof that the water had recently traversed reedy lakes, where it had been filtered, and where, with suitable illumination, its transparency amounts to fully 4 or 5 meters. On the basis of the high-water level (see the accompanying illustration), which was too distinctly marked to have been caused by anything but the latest mus-suji, and on the assumption that the superimposed mass of flood-water had a depth of 0.71 m. and moved at the mean velocity of 1 m. in the second, it is possible to calculate the total volume: it was  $21.60 + 16.30$ , or in round numbers 38 cub.m. in the second.

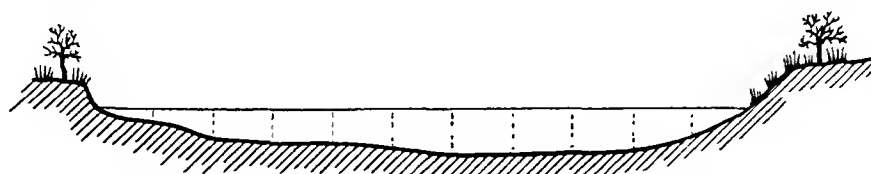


Fig. 158. Right. 0.88 1.55 1.86 1.96 2.06 2.30 2.28 2.17 2.08 1.55 = depth. Left.  
 3 20 16 22 25 35 30 32 25 3 } velocity.  
 18 16 18 30 28 29 29 23 2 }  
 Breadth = 33.3 m. Jätim-tarim, June 3. Scale 1 : 400.

On the 3rd June the Jätim-tarim yielded the following measurements — breadth, 33.3 m.; mean depth, 1.699 m.; mean velocity, 0.2077 m.; and volume, 11.75 cub.m. in the second. The transparency was 1.09 m. Thus the water was here clearer than in the sister stream, but at the same time a great deal more sluggish, an indication that its bed is older. The banks of the Jemischek-kok-alasi are more remorselessly eaten away, its bends sharper, and its alluvial deposits greater in extent, these characteristics being entirely wanting in the lowest parts of the Jätim-tarim. Both streams flow towards the south-east. At their confluence the water of the Jemischek penetrates a little way up the Jätim, though it soon turns again, after uniting with the latter, and so flows on to Arghan. Owing to its having to make the detour through the Tschivilik-köl, the high flood of the Jemischek-kok-alasi arrives later than that of the sister-stream.

At the spot where the great caravan-road crosses our Tarim, by means of a ferry-boat attached to a cable stretched over the river, we obtained the following hydrometric data — breadth, 26.8 m.; mean depth, 1.632 m.; mean velocity, 0.5005 m.; volume, 21.89 cub.m. in the second. This was on the 4th June. On the 1st June I had found the volume to be 21.50 cub.m.; thus in the three days there was a very slight rise.

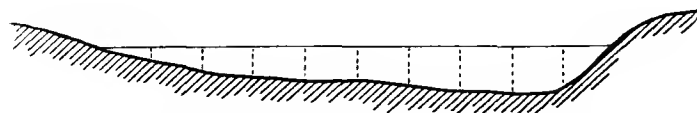


Fig. 159. Right. 0.78 1.29 1.60 1.84 1.85 2.11 2.31 2.44 2.10 = depth. Left.  
 32 49 56 58 59 62 61 51 41 }  
 33 52 58 59 59 62 63 58 40 } velocity.  
 50 63 49 52 62 65 59 41 }  
 40 59 51 58 55 52 42 }  
 70 58 55 48 }  
 Breadth = 26.8 m. Tarim at Arghan, June 4. Scale 1 : 400.



The three streams which mingle their more or less muddy currents at Ajagh-arghan are thenceforward known as Baba-tarim, or the Father River — a name bestowed upon it by the inhabitants of Korla — or Tschong-tarim, or the Big River — the name given by the natives on its banks. If now we add together the volumes of these three streams, we get a total of 55.24 cub.m., or about two and a half times as large a mass of water as we found in the arm which is on the point of dying away and drying up. Beyond Ajagh-arghan, the hydrographic relations become much simpler, in that we have only one powerful stream to study and take note of, instead of the intricate network of anastomosing arms which we have recently groped a passage through all the way from Kepek-uj. In considering this complicated reticulation of waterways, I have thought it expedient, on the ground of clearness, to follow the main river right through without interruption or deviation, leaving till later the descriptions of the several arms which are shed off from it and for the most part rejoin it again at Ajagh-arghan. These were indeed examined and studied separately, each on a special excursion. Yet, as we shall soon see, they do not all re-enter the main river at Ajagh-arghan; two or three of them issue from the chain of lakes which I discovered farther to the east in 1896, and join the principal stream lower down.

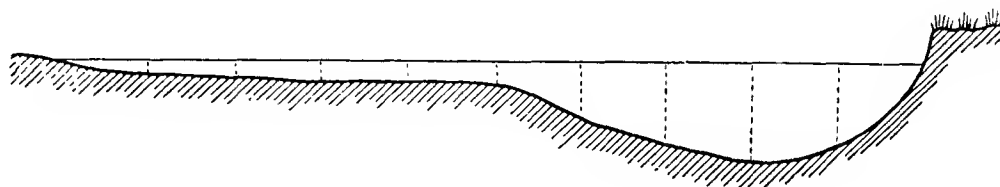


Fig. 160.	Right.	0.63	0.91	1.02	1.13	1.18	3.00	4.05	5.00	4.35	= depth.	Left.
		55	78	78	75	77	79	81	75	85	} velocity.	
		41	65	70	81	87	84	75	99	94		
				69	82	82	70	85	87	115		
							85	74	71	89		
							54	75	109	79		
								66	104	79		
Breadth = 45.35 m. Tschong-tarim at Arghan, June 4th. Scale 1 : 400.												

With the view of obtaining a check upon the accuracy of the three measurements which I have last cited, I decided to measure also the volume of the main stream after the fusion of its three constituent branches. But in this I failed altogether through having chosen an inappropriate place for the experiment. Under the left bank the depth was as much as 5 m., and the current so strong that it was impossible to keep the pole of the velocity instrument steady, as also to perceive in which direction its vane was pointing. The result shows unambiguously, that there was a counter-current, or else an eddy with suction; and this inference is rendered all the more certain by the fact that the velocity at the bottom amounted to 1 m. in the second, while at the surface it was not more than 0.79 m. in the second. Still, I adduce the measurements taken: they were — breadth, 45.35 m.; mean depth, 2.127 m.; mean velocity, 0.7576 m. (this is the datum, the mean of 36 measurements at different points, which is faulty, for at several of these points the





result should, properly speaking, be designated by a minus value); volume, 73.08 cub.m. in the second. This last datum shares of course in the error which attaches to the mean velocity. Two days later I was able to take a satisfactory series of observations, and I then ascertained that the correct result for the volume was 55.24 cub.m. in the second.

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## CHAPTER XIV.

### BOLDSCHEMALS, THEIR FORMATION.

Before proceeding further I will advert to the morphology of the river-bed in this part of its course. Pl. 36 shows two stretches of the river, the one traversed on 28th May, the other on 2nd June. Each was covered by our ferry-boat in the space of one hour, and as it was kept as usual to the swiftest part of the current, the probability is that it passed over the deepest places in each section. The depth was sounded once every minute, so that each series of soundings indicates approximately the depths of the deepest trench along the river-bottom. I say approximately only, for an exhaustive map of the river-bed would require as many transverse lines of soundings as we have points along the river's direction of flow, and, in addition, soundings from several points along each transverse line. The two illustrations show distinctly, that the effects of erosion upon the bottom are most pronounced at the sharp bends, where a bottom eddy is created by the rapid turning movement of the water. This not only prevents sediment from being deposited there, but it actually digs deeper the river-bed itself. Where the river flows straight, the depth is relatively less accentuated.

The illustration of 28th May shows also what great efforts the river makes to cut off these bends or loops. It shows us a strongly marked loop, the neck or »stalk» of land at the base of which is eaten into every year deeper and deeper from both sides simultaneously, until ultimately it becomes so narrow that — unless the river meanwhile alters its course — it must inevitably be cut through, and the loop left on one side. Indeed, it is very likely that this neck of land would have been already severed, were it not for the interlacing network of roots which bind the dunes together, and so augment their power of resistance.

The subjoined series of illustrations depict seven different stages in the origination and disappearance of a bend or loop. Pl. 36 shows us what is the present aspect of the loop. The dividing line between the naked alluvia and the older alluvia which support vegetation indicates the direction in which the current has been at work in the immediately preceding period. With this to guide us, we arrive at the conclusion, that during a previous stage of its development the loop presented the appearance

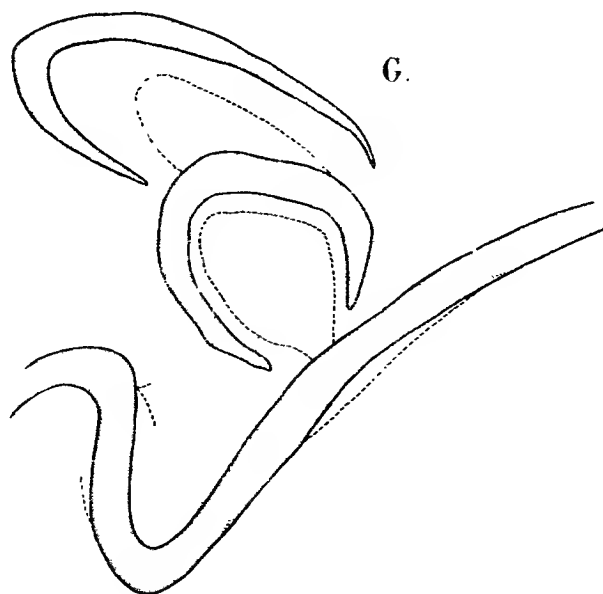
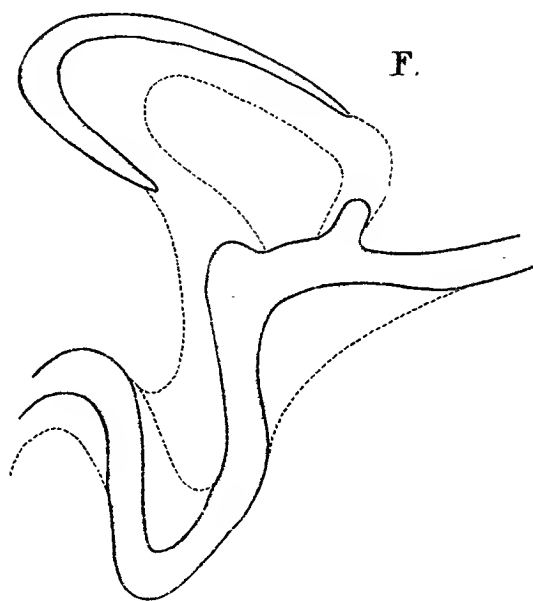
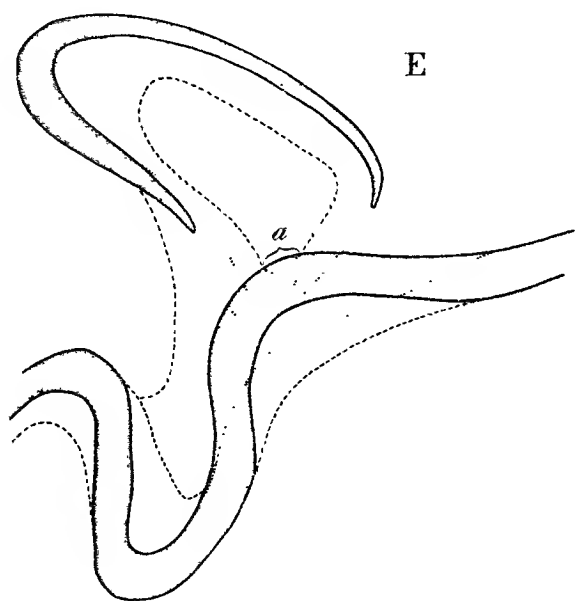
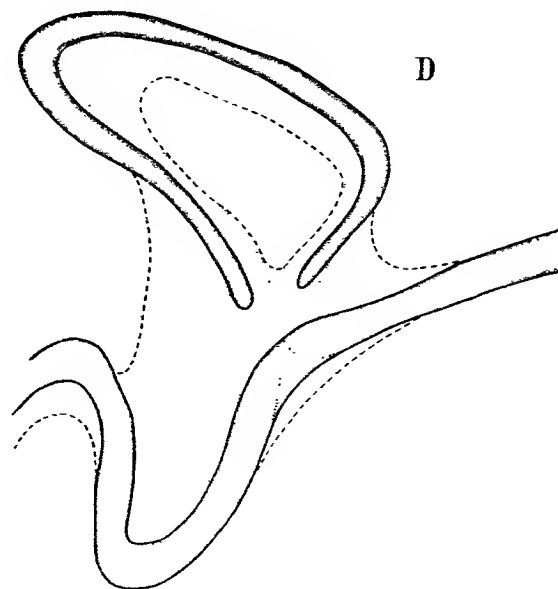
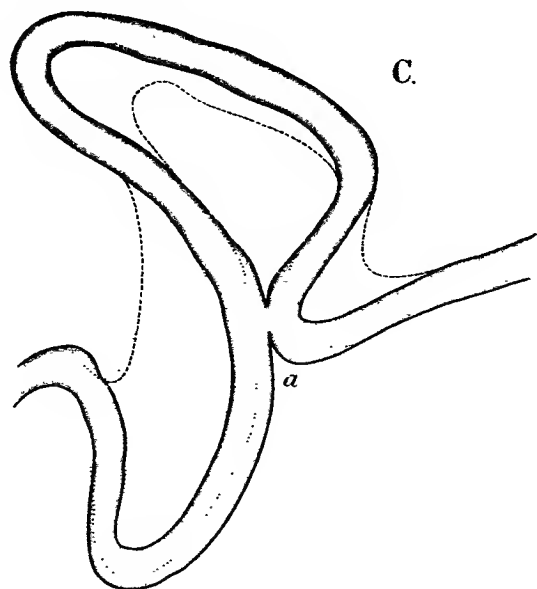
shown in A Pl. 36. The arrows indicate in which directions the banks move in consequence of the lateral erosion of the stream; while the dotted outlines show the shore along which the sediment is deposited, whilst at the same time the opposite bank is made more and more concave. It is the concave portions of the banks which are eroded, and the convex portions against which their crumbling material is deposited. That these correlated results must ensue is a sheer physical necessity, and requires no explanation. Nevertheless, I will not withhold the results of the observations which I made with my own eyes in hundreds of the windings of this great and interesting river. The ground through which the Tarim flows is composed of very loose and very homogeneous materials, materials that not only crumble down imperceptibly, but possess so little power of resistance as to exhibit with especial clearness and pregnancy the river's correlated energies, both the *destructive* (erosion) and the *constructive* (sedimentation), as the study of my map will abundantly illustrate. Possibly there is nothing new in my observations. The only claim I advance for them is that in their totality they furnish a contribution to the characteristics of the Tarim, and to that extent may possibly corroborate the investigations of more competent observers.

All I would be understood to affirm therefore is that in a country like East Turkestan, where the inclination is so inconceivably slight and uniform — indeed the contour is almost a dead level — and the soil so homogeneous, it cannot be but that the rivers *must* wind, *must* be serpentine. There are always minor irregularities in every surface; so here. In one locality firm compact clay forms a more essential element in the constitution of the soil; in another locality the preponderating constituent is loose sand. Then, apart altogether from this, a belt of vegetation, perhaps nothing more than a few tamarisks, with their long tenacious roots, is quite sufficient to cause a slight deviation in the river's direction. And once it has begun to deviate, no matter from what cause, it proceeds farther of its own accord in the direction thus — one might almost say — »suggested» to it. But when the deviation has developed to a sufficient, and definite, degree, the river acts without the slightest regard to the nature of the ground, whether it be bare soil or whether it be bound together by vegetation. The force which is brought into play — and the sharper the curve the more vigorous the activity of the force — is the centrifugal. The mass of water naturally seeks to flow straight onwards, that is, to retain the direction in which it has last been moving. But it is forced by its restraining barriers to swing off at an angle (see fig. A), sometimes even at a very acute angle. In consequence of this manœuvre its energy of movement becomes converted into another kind of energy, namely erosion, and this expends itself upon any obstacles that lie in its path. As a consequence of the centrifugal action thus set up in the stream, the surface ceases to be precisely horizontal, but assumes the angle of inclination shown in an exaggerated form in fig. 161; that is to say, the water that is sucked away from the convex bank becomes heaped up under the opposite or con-



Fig. 161.

cave bank, with a consequent local rise of level in that part. The distance which the stream has to traverse in the same space of time being shorter on the convex, than on the concave face of the loop





(see fig. 162), it follows that the current must there move proportionally slower. The water which thus flows next the convex bank of the river does not exercise any erosive action, for the simple reason that there is nothing for it to exercise that power upon, for it is all the time endeavouring to get away from the adjacent bank. At the most, the only pressure it exerts is pressure upon the strata of water which lie outside of it, that is in the direction of the concave bank. But in consequence of its relatively diminished rate of flow,

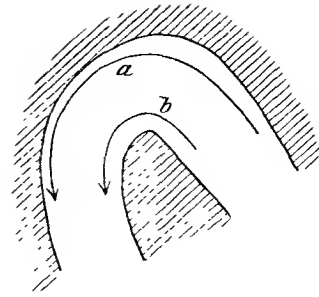


Fig. 162.

this marginal section of the stream begins to deposit the sedimentary matter which it holds in suspension, and deposits it precisely along the outer periphery of the convex promontory, where, as a matter of fact, we always find the crescentic silt-beds and flattened spits of sediment that are so characteristic of this river. Thus, while we may designate this the passive side of the river, the opposite or concave side is obviously the active. It is from this latter that the stream is continually loading itself with fresh sedimentary material, which it deposits in large quantities on the first strip of alluvium that it comes to, but the major part it transports farther, gradually discharging it as it advances. At the same time it keeps on charging itself anew at each fresh concave angle it enters, so that the water is never clear, unless in those places where exceptional circumstances prevail, such as in the reed-grown lakes and marshes which I have recently described.

In this way the loop we are considering has developed from the state shown in A to its existing condition as shown in Pl. 36, May 28th. But the latter no more represents a stable or permanent condition of things than does the former. For the concave shape grows more and more pronounced, the alluvial peninsulas continually widen out, while their areas increase, and at the same time the two eroded banks gradually approach one another, the neck of land at the base of the loop becoming unceasingly narrower. The eastern side of the neck appears to advance faster than the western side because the strip of alluvium opposite to it is broader. Still this may also be attributable to the nature of the ground and its conformation, and to the readiness with which the reeds establish themselves on the new alluvium. For as soon as the high water ceases to reach the inner side of an alluvial peninsula, its bare silt soon becomes overgrown with reeds; then bushes quickly follow, though, as we have seen above, when describing the Jarkent-darja, the poplar does not establish its footing so readily; in fact, it does not keep anything like pace with the other vegetation, nor with the development of new bends or loops. Consequently the poplar woods are confined to the scarped concave banks, where the river, disregarding all obstacles, actually encroaches upon the forest.

A little consideration of the series of soundings obtained in the loop we are discussing will show that the greatest depth is not found adjacent to the narrowest point of the neck of land; for there the maximum depths were only 2.74 and 2.44 m., whereas in the immediate vicinity we had depths going down to 4.80 m. The reason of this is, that the neck consists for the most part of loose sand, which yields very readily to the assaults of the water. The bank immediately above the spots where the greatest depths occur possesses however greater power of resistance, owing



to its being interlaced with tree-roots. Hence on each side of the neck of land it is lateral erosion which is the more energetic, but in the deep places bottom erosion.

Lower down the Tarim there do however occur many abandoned loops, resembling a ring drawn round a flourishing patch of forest. Here, in spite of the protection afforded by the network of roots, the neck has nevertheless been cut through. Probably the only difference has been that the process of breaching the isthmus has been spread over a longer period; the result is equally the same, and the river, in effecting the breach, has wrenched away some of the trees. Drift-wood, self-anchored to the alluvial deposits, is quite common in the lower Tarim.

Our loop next assumes the appearance it exhibits in B, Pl. 36, in which it is merely a question of time before the rapidly narrowing neck of land shall be severed. This occurrence is shown as *un fait accompli* in C, Pl. 37. In by far the greater number of cases the breach or severance probably takes place at the period of high water, when the river swells to twice its volume, and possesses incomparably greater power, than at the period of low water. How precisely the breach is effected cannot be exactly described; indeed, it would be as vain to hope to be an eye-witness of such an occurrence as it would to stand still and wait for the fall of a meteor. Both events do unquestionably occur often enough; but for a man to be an actual eye-witness of either could only happen by the merest chance. All the same it requires no great effort of imagination to picture what does take place. Fig. 163 shows in sectional outline the neck of land and the adjacent part of the river-bed, drawn in correspondence with the straight line in Pl. 36. The dotted lines on fig. 164 show the advance of erosion in its assault upon the narrowest part of the neck, and the deposition of alluvium under the opposite bank. The ruled areas show the two sections of the river just after the breach has occurred, and the last buttress of earth has fallen in and become the prey of the stream. The condition of affairs is coincident with that depicted in C (Pl. 37), though in all probability it does not last longer than a couple of minutes or so, for it is against this bank that the centrifugal power of the river is exerted. The water rushes in through the breach, the sharp point is washed away in the course of two or three days, and the remaining portion of the little isthmus, lying beneath the surface, is speedily levelled down (see *a* in fig. C). The portion of the river which is left in the loop itself remains there in the shape of a crescentic pool of stagnant water adjacent to



Fig. 163.

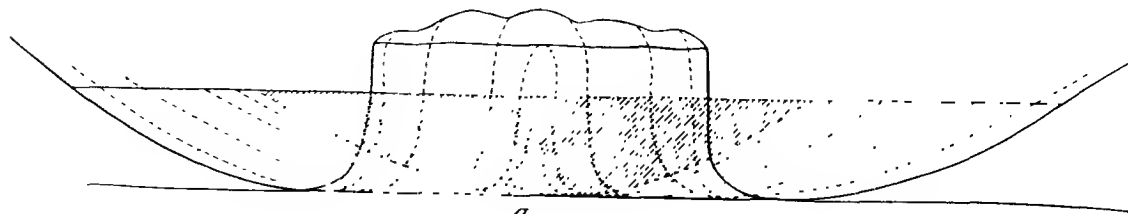


Fig. 164.

the right bank. Indeed these abandoned loops of dead water are so characteristic of almost the whole course of the Tarim that the natives possess a special word for them. They call them *boldschemals*, distinguishing them from *köl*, a »lake»; *dschajir* and *uktu*, which mean a »little lake»; *jarsuk*, that is »dead water» in a river-bed through which an active current is flowing; *daschi*, a »salt pool»; *bikar-darja* or *taschkan-su*, i. e. »idle» or »flung away water», indicating arms which break away from the river, and do not return to it again, and thus serve no real purpose. The only point common to a *taschkan-su* and a *boldschemal* is this last, their uselessness; on the other hand, while the former drains the river to a certain extent, the latter is cut off from it once for all, and gradually dries up. In fact, the river's tendency to discard and free itself from these loops as fast as they grow successively »ripe», is an occurrence of such a striking character that it could not very well escape the observation of the natives. In process of time the *boldschemals* get filled with dust, drift-sand, and vegetation, and disappear. I have said it would be a mere chance if one were to be an eye-witness of the actual formation of a *boldschemal*. And yet *boldschemals* are formed every year in numerous places all along the Tarim;

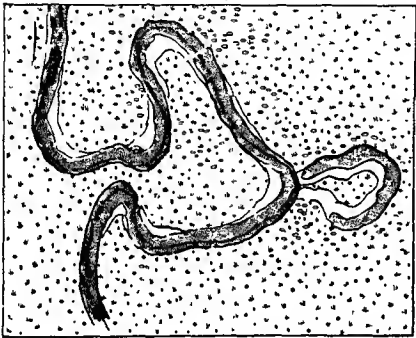


Fig. 165. THE BOLDSCHEMAL OF KALTA-TOKAJ.

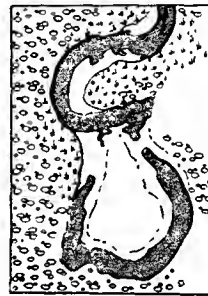


Fig. 166. THE BOLDSCHEMAL OF JAGHLIK-TSCHOKÖN.

and those which have been abandoned, and left on one side, by the river during the course of its centuries of flow may be numbered by thousands. In the history of the earth the life-story of a river like the Tarim, which, even in the moment of time that makes our epoch, only manages to maintain a precarious existence as the result of an incessant struggle, is nothing more than a merely ephemeral episode, and in the eyes of the historiographer the loops which this great river makes come and go like the bubbles of froth on the dancing tide. And yet, in virtue of their great number, they are a facile instrument in the hand of the river for levelling a broad zone of the country through which it flows. Old loops are cut off and disappear, and new loops are formed, only to perish in their turn. The materials of disintegration are distributed equally over the face of the region, and fresh masses of sand and silt are gradually loosened, separated, and transported down the river.

Returning to fig. D (Pl. 37), — here we have all the conditions necessary for the formation of a fresh loop, one which will come into being inconceivably swifter than the old loop did. For whereas the latter had first to overcome the opposition offered by the roots of the forest-trees and other vegetation which bound the soil together, the new formation will find the ground ready prepared for it, and will

have nothing to contend against except sand and silt. For the ground has been already »worked» by the older loop; that is to say, it is already ploughed up and loosened, and there is no vegetation left. Hence the situation shown in D cannot be of any long duration; indeed the change shown in E will be brought about in the same high-water season that witnesses the breach. And as a matter of fact we do find, in the case of the great majority of these boldschemals, that the river has worn away to a gently curved line ( $\alpha$  in fig. E) the sharp extremity of the island inclosed by the boldschemal. But whilst the boldschemal itself has been undergoing metamorphosis, the island which forms its nucleus has remained unchanged, and the resistance now offered by its vegetation compels the water that is left in the boldschemal to take the shape depicted in fig. F. As time goes on, the water area of the boldschemal steadily decreases; this stadium is exhibited in, for instance, the boldschemal shown in fig. 165 and 166. In nearly every case there is an interval between the two blunted horns of the river which penetrate the upper and lower extremities of the boldschemal respectively; it is very rarely indeed that they both coalesce into one, as in fig. D.

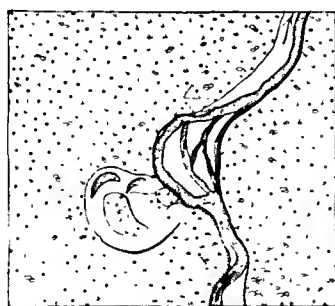


Fig. 167. JA-KOTAN, 20 OCT.

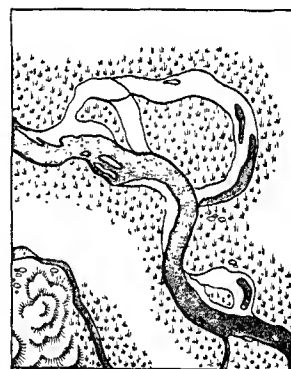


Fig. 168. DOUBLE BOLDSCHEMAL  
BELOW DANGSUR-KÖL, 6 DEC.

Let us follow the development of the loop yet one stage more from fig. F. In fig. G we have the newly formed loop cut off in its turn, and now forming a boldschemal. Fig. 167 shows a double boldschemal of this kind, which we passed at Ja-kotan on the 20th October, and fig. 168 another below Dängsur-köl, Dec. 6th. This will show that I have not deduced this later stage as a result of reasoning, but that the condition actually does exist, although I admit instances of this particular formation are extremely few. The explanation is that, in the majority of cases, when boldschemal No. 2 is ripe for being cut off, boldschemal No. 1 is already dried up, and choked with sand and vegetation.

Upon comparing the first and the last fig. in our series, it is almost impossible to recognise in G. the self-same loop that is shown in fig. A; nevertheless it has gone through all the intermediate stages of metamorphosis. Yet G is just as far from being the final stage as A was. In fact, there exists only one reason why the process should not go on for ever, and that is the fickleness of the river. The only portions of the river's course in which one can imagine loops exhibiting yet

many other stadia of development than those which I have described are those in which it remains on the whole pretty constant to one bed, as, for instance, in the Jarkent-darja. In the lower Tarim however this essential condition is wanting, and consequently the development of the loops in that part are sooner or later interrupted whenever the river seeks an entirely fresh bed. Then fresh loops are formed, whilst those in the former bed dry up, become filled with sediment etc. and vegetation, and finally disappear. Fig. 169 shows in outline a panoramic view of stadium B in the loop we are considering; the visible parts of the eroded bank stand out very much darker, as though they lay in the shade. My reason for dwelling in such detail upon this topic is that in the portion of the Tarim which we are now about to consider boldschemals are extraordinarily plentiful. They are also very numerous for a long way below the confluence of the Ak-su-darja, as I mentioned whilst describing that part of the stream. The river there flows generally faster, and carries a greater volume, so that the loops probably grow at a more rapid rate.

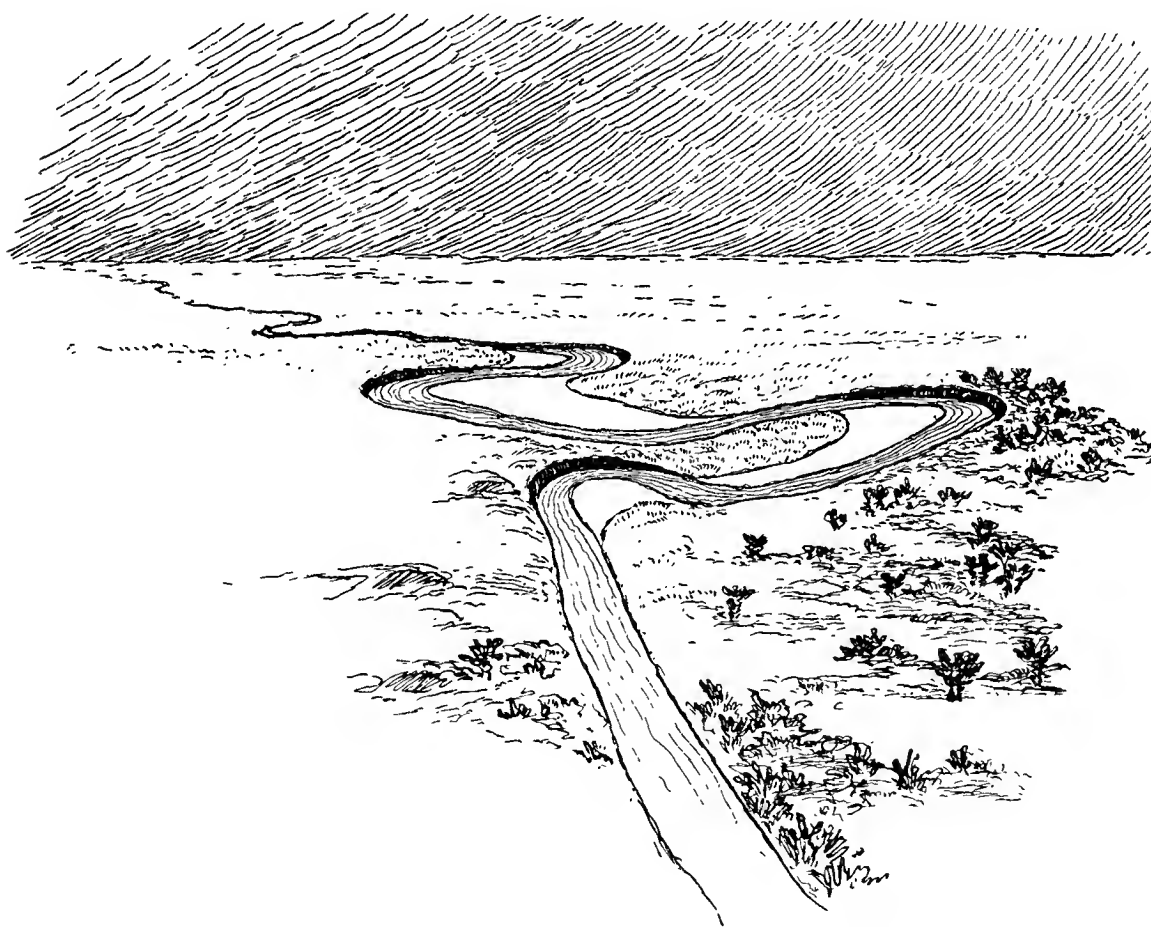


Fig. 169. PANORAMIC VIEW OF STADIUM B IN THE LOOP.

There is also another reason why it is profitable to discuss this problem at some length, for it involves as an implicate that the topography of the river is constantly and uninterruptedly changing. The map of the Jarkent-darja and the Tarim, which I reproduce in the accompanying atlas, cannot, from the topographical

point of view, lay claim to possess more than an ephemeral value. It says in effect only, »Thus it was the river appeared in the autumn of 1899 and early summer of 1900«. But how long it will correspond to the actual state of things it is impossible to say. One thing however I do know for certain, and that is, that there are two powerful factors constantly at work modifying the topography of the river, namely (1) alterations in the river-bed for longer or shorter distances, and (2) local changes caused by the formation of loops (*boldschemals*). Hence a map of the Tarim so far resembles an edition of Baedeker or a statistical handbook, that it soon gets out of date and ought to be issued in a succession of new editions. A century hence only the broad topographical features of my map will admit of being identified with the then existing conditions. Perhaps the local nomenclature will to a large extent still remain, and so will be helpful as a guide for identification. This notwithstanding, the map is, I believe, possessed of considerable value for the physical geography of the regions traversed by the Tarim. For, disregarding what is surely an idle reproach, that it is not worth the trouble to map a river on such an extensive plan, and on so minute a scale, as I have adopted in the present instance, my map, when all is said and done, is, and will be, a document by means of which it will be possible twenty years hence to determine, on the basis of exact figures, in which direction and in what manner the stream has altered its course. Geography expects from modern explorers, that they shall construct accurate maps of the topography and relief of the earth's surface, and the expectation is one that may not be set aside. With the help of the material and the exact quantitative measurements which we collect, and shall hand down to them, the geographical inquirers of the future will be able to arrive at conclusions of the utmost exactitude, such as we can hardly conceive possible, because a hundred years ago scientific workers did not demand anything like the same exactitude and precision that we require at the present day. In view of these considerations I do not look upon the laborious work I have put into the mapping of the Tarim as efforts that have been wasted. There will come a day when it will be esteemed at its proper valuation, and then the results which I only perceive dimly will be established with mathematical precision.

But it is time to return to Arghan. We found that on 3rd June the arm of the river which came from the north — and which, for simplicity's sake, we will call by the name of its best known, though by no means its biggest, branch, the Jätim-tarim — carried a volume of 33.35 cub.m. in the second. The stream which we followed — here coming from the south-west — had a volume of only 21.89 cub.m. in the second; and yet on the very newest maps, e. g. my own in *Petermanns Mitteilungen*, *Ergänzungsheft*, No. 131 and *Stieler's Handatlas*, map No. 62 (1902), it is represented as being the principal stream. This was unquestionably the case at the time of Prschewalskij's first visit, and this particular stream is even here actually known as the Jarkent-darja, an indication of its priority of existence. But it must now be deposed from the position of honour, and will in due time be mapped as an old dried up and forgotten bed.

The accompanying sketch-map (Pl. 35) gives a faithful picture of the relief of the river-bottom at the confluence. It shows that the Jarkent-darja possesses at its termination a perfectly regularly formed channel. The greatest depth occurs nearest

to the left bank, where in general the current moves with the greatest velocity. Precisely the same thing holds good of the Jätim-tarim, and in both cases alike it is the sinuous character of the river which is the determining factor. But while the depth of the Jarkent-darja nowhere exceeds 2.60 m., the Jätim-tarim gave soundings of 6.25, 5.50, 7.45, and 4.15 m. It is just above the confluence that the latter descends to 7.45 m., but at the actual confluence its depth is 4.15 m., possibly a result of the retardation of its current through contact with the water of the Jarkent-darja, whereby sediment is deposited. A similar phenomenon occurs in the mouth of the Jarkent-darja, namely a small mud-bank with a depth of only 1.45 m. of water over it. At the actual point of confluence there is an eddy, which has scooped out a deep hole in the river-bed, and it is along the continuation of the line of contact that we obtained the maximum soundings in all that region, namely 8.22 m., while adjacent to it were depths of 8.03, 7.40, and 7.15 m. But the conversion of the force of movement into the force of excavation, which is occasioned by the violence of the confluence, the resultant eddy, and the great depth, retards the velocity, so that below the union of the two rivers the Baba-tarim is both shallow and broad. Along the line of sounding marked No. VIII the greatest depth is thus only 2.52 m., and along the two following lines. (Nos IX and X) 3.03 and 2.07 m. respectively. At each of the last two lines the breadth was almost exactly 70 m.; but at the next line of soundings, where the river had contracted to 45.35 m., the depth went down to 5 m. That is as much as to say, that below the eddy of the confluence the river expands and grows shallow, while both south and east of the eddy there are very extensive sedimentary deposits. Those in the latter quarter are continuous with *terra firma*, but the former are built up into an elongated island, with, on the inner side of it, a broad strip of barren silt, which was laid down at the period of high water. The extremity of the blunt-ended peninsula between the Jarkent-darja and the Jätim-tarim also consists of silt, and has a pool in front of it. There cannot be a doubt that all these sedimentary deposits become covered with water at the season of high-flood in the autumn.

We have found that the total volume flowing through the three arms we measured was 55.24 cub.m. in the second and the mean velocity of the three is easily determined to be 0.448 m. in the second. Along the line of sounding No. XI, taken between the southern extremity of the silt island and the left bank of the river, the mean velocity was 0.7576 m., although the area of a vertical section measured only 96.46 square m., as compared with 134.28 square m. in the three united streams; but then in their case the friction was greater. The sum of their separate breadths was 78 m., as compared with 45.35 m. in the conjoint river, or the river below the confluence. In this latter it is possible that the fall is also a little greater downwards from the silt-bed which has formed below the eddy.

The last preceding measurements, which were taken at Kirtschin on the 23rd May, yielded a volume of 78.58 cub.m. in the second. Here however on 3rd and 4th June, after all the river-arms had become united into one channel, we had a volume of only 55.24 cub.m., or a decrease of 23.34 cub.m. in 12 days. To a certain extent this diminution depended upon the season of the year, it being the period at which the river steadily drops, but also, and to a greater extent, upon the fact that

a portion of the water of the Tarim has chosen a more easterly path, of which more subsequently.

After the river became frozen the Tarim (Jarkent-darja) had at Arghan (*a*) a breadth of 71 m., and on the 18th February 1900 a breadth of 59 m.; the Jätim-tarim (*b*) measured 34.10 m. and 23.9 m. respectively; and the united river 92.2 and 76.8 m. respectively. At the spot where the ferry-boat which serves the caravan road crosses the Jarkent-darja (at Arghan) the corresponding measurements were 28.1 and 23.1 m. Holes were chopped in the ice at *a*, *b*, and *c*.

	Depth of River.	Thickness of Ice.	Breadth of River.
( <i>a</i> ) . . . .	2.59 m.	0.38 m.	59.0 m.
( <i>b</i> ) . . . .	3.65 »	0.50 »	23.9 »
( <i>c</i> ) . . . .	6.49 »	0.56 »	76.8 »

The fact that both the Jemischek-kok-alasi and the Jätim-tarim had very transparent water, namely 0.60 and 1.09 m. transparency respectively, suggests yet another observation. Unfortunately I omitted to measure the transparency in the mouth of the Jarkent-darja at Arghan, although I remember that the water was perfectly bright, much brighter at any rate than it was above the point where the river becomes lost amongst the lakes. The obvious reason of this is that all the arms which converge upon Arghan have passed through the clearing-basins of the reedy lakes, leaving behind them on their floors all the sedimentary matter they carried in suspension. Whence we may conclude, that none of the sediment which the stream transports past, say Jangi-köl, travels so far down as the Kara-koschun, at all events at the relatively low level which the current exhibited at the time of our visit. The sand which the river filches from the skirts of the desert is deposited before it travels very far; and such finer particles as have not already gone to the bottom certainly do so upon reaching these lakes. Thus, whilst the newly-formed mud-banks raise the river-bed and force its current to change its position, the finer sedimentary matter helps to fill up the lakes and raise their bottoms *au niveau* with the adjacent country. In this way the Kara-koschun is robbed of a large quantity of the sediment which would otherwise assist to fill it up. This at any rate is the state of things hydrographically *now*, though the fact is only temporary and transitory. It can be proved, that several such basins have previously existed; those which now exist are of recent origin, and will in their turn also be filled up. As soon as this is accomplished, the entire body of sediment will travel on all the way to the Kara-koschun, as indeed has certainly been the case more than once already in the past. Then however the river will build up ramparts, and between them new lakes will be formed. Meanwhile it is interesting to observe, that the lake-basins, which have formed beside each of the three arms into which the lower Tarim here divides, are situated approximately upon the same degree of latitude. We have already noted the long string of lakes which accompany the arm down which we drifted in the ferry-boat. Beside the Kuntschekisch-tarim or Ara-tarim there are the large lakes of Tschivilik-köl, Ghodajlik-köl, and several others; and there is yet a third long series of lakes hanging upon the Ilek branch, through which

flows the water of the Kontsche-darja. The formative significance of this relation I shall discuss at a later stage, though it seemed not inexpedient to direct attention here to the existence of this hydrographic homology, as well as to the function which these lakes discharge as receptacles for the fluvial sediment. The water, when it enters them at (*a*), is muddy; but when it leaves them at (*b*), it is clear. The sediment settles on the lake-bottom; though when the lake gets filled, the water at (*b*) is likewise muddy.

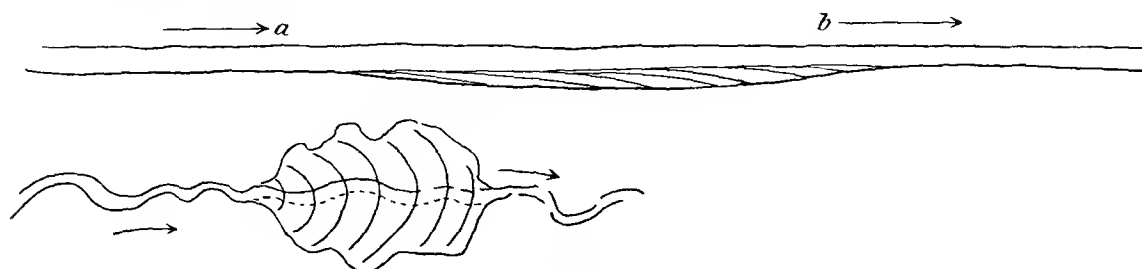


Fig. 170.

## CHAPTER XV.

### FROM AJAGH-ARGHAN TO JURT-TSCHAPGHAN.

On 5th June we continued our drift down the Tschong-tarim, with a flood of 55 cub.m. in the second. Shortly after starting we passed two abandoned loops, Sogot on the left and Kasan-sindi on the right. Both still contained water, although the natives told me these boldschemals were abandoned some ten or twelve years ago. At the present time the river flows pretty evenly between them both. As

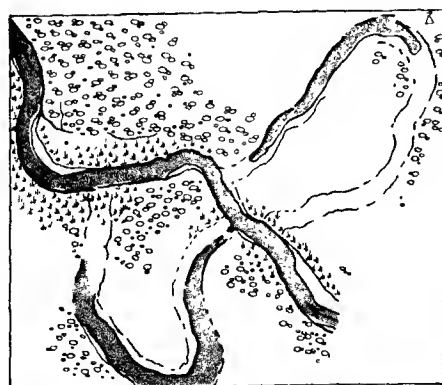


Fig. 171. THE BOLDSCHEMALS OF SOGOT AND KASAN-SINDI AT THE PRESENT TIME.

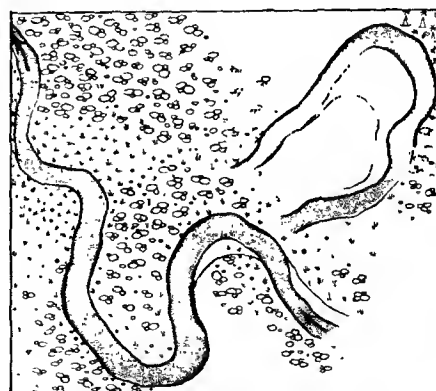


Fig. 172. COURSE OF TARIM WHEN KASAN-SINDI ALONE WAS ABANDONED.



their history is in some respects different from the example I have already commented upon, I will add a series of sketches illustrating them as well; but they are such as to require no further explanation. About twenty minutes farther on we passed yet another similar pair of *boldschemals*, that on the left called Tajek Pavane-joleg-ottogho, while the one on the right was nameless. Both contained pools of water, and were embowered amid magnificent poplar forests of considerable age. All along we had on our right the Al-katik-köl, which, although now dried up, was once, I was informed, a lake of great size; but the canal or canals which connected it with the river have disappeared without leaving any traces behind them. The bottom of the lake (*kölning-dschaji*) is now completely overgrown with dense reeds, tamarisks, and other bush vegetation. The space between the river and the lake is occupied by forest and steppe, and on the west of the lake towers the high sand, although we only saw its yellow summits peeping above the reed-beds once or twice all day. I was told that there are a few solitary poplars still growing even on the same shore. Next came, on the left, a pool, the last surviving remnant of

some old *boldschemal*, and then immediately below it yet another. This last, which rejoices in the name of Jaghlik-tschökön-otak, is wonderfully distinct and beautifully formed, with the horn-like expansions of the river penetrating into the old channel at each extremity, and a crescentic pool at its inner or middle part.

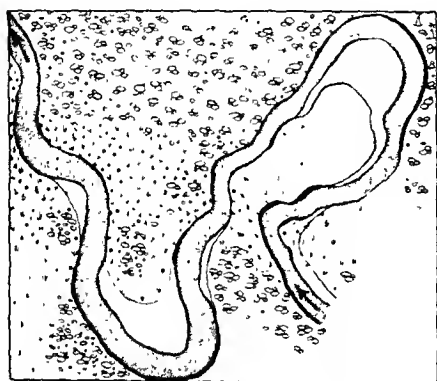


Fig. 173. COURSE OF TARIM BEFORE FORMATION OF THE TWO BOLDSCHEMALS.

After that the river flows pretty directly towards the south, though as usual with numerous sinuositities, none of them however especially sharp. Upon reaching some low sand, with vigorous poplar forest growing amongst it, I was informed by my guides, that we had here reached the end of the Al-katik-köl. Here again, along a very short stretch of river, we discovered a third pair of *boldschemals*, one on

each side, each plainly distinguishable and regularly formed, in all respects like those we have already noticed. The one on the right was called Arghamtschi-baghjadi. Its neighbour on the left was without a name; it was formed in 1898, and was full of water, like its *vis-à-vis*. The water in their upper extremities approached within two or three meters of the present water-line level of the river, and there can be no doubt that, at the period of high flood, water flows out of the river into both these abandoned loops. This I infer partly from the contour of the surface, and partly from what I was told, namely that both *boldschemals* are first-rate fishing-grounds. For whilst it is true that there might be fish in the deeper parts of the loop at the time it was cut off, still these would soon have been all caught in the nets of the natives, so that it is only where the stock of fish is kept up by the repeated inflow of the river that one can legitimately speak of good fishing-waters. Although it is not known when these *boldschemals* were formed, I should say that the one on the right is the older, at all events it contained the greater quantity of water. But after all there cannot be any very great difference in their ages, for the very fact of the

upper loop being cut off at once increases the pressure of the stream, and accentuates the erosive energy it exercises upon the lower promontory, as may be seen from a glance at the above fig. 172. Hence, when the upper loop is cut off, the lower does not long escape the same fate. This circumstance will to some extent explain the peculiarity of the loops occurring here in pairs.

Directly east of the last pair of boldschemals is the district of Kum-tscheke, with which we shall become better acquainted later on. The forest was still abundant, and the poplars strong and well grown. The natives estimate this forest to be one hundred years old. Below Arghamtschi-baghladi the river describes a loop with such a narrow base, or neck, that it must infallibly be broken through at the next high water. Indeed on the left of the river there is a loop of this character at Kodakekojghan. However difficult it may sometimes be to combine the statements of the natives, or to procure confirmation of them, they are nevertheless always of great importance, for they are entirely free from speculative bias, and rest solely upon personal observation or family tradition. Thus it is to my old, well-tried guide, Kirghuj Pavan, a man especially well versed in the geography of that country, that I owe the information, that the full flood of the Tarim never flowed down the now dry bed of the Ettek-tarim, but at least a portion of it always travelled along the path we followed with our ferry-boat. Seventy or eighty years ago the river flowed through the Kara-köl and Ilek (the waterway which Kirghuj Pavan guided me through in 1896), and at that time the river was called the Merdek-tarim (see below). But at the period indicated the river flung itself into its present channel and into the Ettek-tarim, while the more easterly bed which it deserted became converted into a chain of detached salt-lagoons. Thirteen years ago however a not inconsiderable portion of the stream returned again to the old watercourse on the east.

In the district of Kulatscha our river was joined from the left by another *kok-ala*, coming from the Ilek at a point a little above the village of Kulatscha, situated on the latter stream. This name is consequently common to both rivers, and indeed the distance between them is so short that a man shouting beside the one Kulatscha can be heard at the other. The canal, which was made by shepherds, is a very small affair; generally it is hidden in the reeds, but at one spot where there were no reeds and where the canal split into three arms, it carried a volume of 0.3 cub.m. After passing yet another loop, we came to Kulatschane-ajagh-tscheke, or Kulatscha's Lower River Loop, where there was a boldschemal with a pool. This is a *kötörmesa* or »portage», by which it is possible to avoid the long row round. On the left we had a pool which wore the appearance of a boldschemal, though I was informed that it was only the termination of a dried-up *kok-ala*.

June 6th. Just above our camp stood, on the right bank, a completely isolated conical hill, about 10 m. high, which is considered by the natives to be the highest piece of firm ground beside the lower Tarim. To the south-west, and tolerably near, there is a pretty big outlier of the high sand, but in the west the desert recedes to a great distance; in fact, in that direction we were unable to perceive anything except level steppe. At our camp the river was joined by the Almontschuk-kok-ala, a deep, narrow arm which leaves the eastern Ilek immediately below Kulatscha, and flowing south-west, enters the Tschong-tarim in a long serpentine boldschemal, which

was destroyed about 15 years ago. On its banks there is still some forest left. The canal of Almontschuk-kok-ala contained a copious supply of clear water and was well stocked with fish. Near its mouth it is crossed by a simple pile bridge made by the shepherds. Between the Ilek and the Tarim this canal traverses a lake of medium size, the Karaune-tokkan-köl, which is practically overgrown with reeds, and also a smaller lake which possesses no name. At noon the water of the main river had a temperature of  $23^{\circ}.5$  and that of the canal  $24^{\circ}.2$  C. The dimensions of the latter were — breadth, 11 m.; mean depth, 0.794 m.; mean velocity, 0.2005 m.; volume, 1.75 cub.m. in the second. This then was the quantity of water which the dwindling Tarim received from the Ilek. After about the end of June, when the Tarim has dropped lower than the Ilek, the current in the Almontschuk is a little augmented.

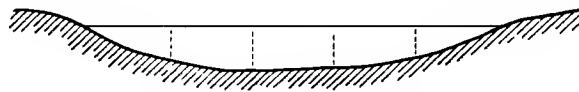


Fig. 174. Right. 0.94 1.15 1.03 0.85 = depth. Left.  
0.12 0.20 0.25 0.23 = m. in a second.  
Breadth = 11.0 m. Almontschuk, 6 June. Scale 1 : 200.

In the autumn, when the Tschong-tarim reaches its highest level, the current is said to flow in the opposite direction, that is from the Tschong-tarim towards the Ilek, the maximum of the latter being considerably retarded by the large lakes which lie above it.

Above the mouth of the canal the Tschong-tarim had the following dimensions — breadth, 38.10 m.; mean depth, 1.593 m.; mean velocity, 0.8353 m.; and volume, 50.70 cub.m. in the second. The diminution as compared with the measurement (55.24 cub.m.) taken at Arghan was the result of the daily drop in the level of the river. Below the canal mouth we found the volume to be 52.45 cub.m.

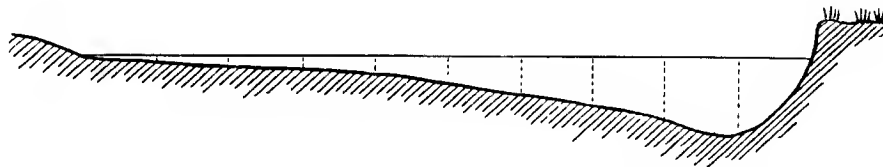


Fig. 175. Left. 0.28 0.52 0.72 0.98 1.44 2.00 2.69 3.30 4.00 = depth. Right.  
28 50 65 78 85 91 95 110 115  
24 44 61 73 82 90 93 105 107  
49 59 80 89 91 99 104  
72 85 90 97 96  
86 98 97 } velocity.

Breadth = 38.10 m. Tarim at Almontschuk, 6 June. Scale 1 : 400.

This region was extraordinarily lifeless. Since we said good-bye to Supa Bek's people, who helped us through the reedy lakes, we had seen but one solitary human being, the old woman left in charge of the station-house of Arghan. Every hut we came across was empty, and both shepherds and flocks were entirely absent; indeed the last-named would have been tormented to death by the gad-flies, which at that season of the year make this country almost uninhabitable. And these plagues

would appear to act as a deterrent also to the animals of the chase, for we saw not a single wild boar or antelope.

Just after leaving camp we passed on the right a large distinct boldschemal, and in the district of Kalta-tokaj yet another, which resembled an excrescence growing out of an almost completely circular loop. Indeed as soon as the river shall have cut its way through the very narrow stalk or neck of land at its base, as it will do soon, there will arise yet another example of the double boldschemal. Thus we have found that there exist three distinct types of this peculiar formation — (1) the single boldschemal, situated on either side of the river; (2) boldschemals in pairs, one on each side of the river, immediately opposite to one another; (3) double boldschemals, of which one is as it were a parasite or excrescence upon the other.

Next we came on the left to a second kok-ala from the Ilel; it begins at Sejt-uj below Kulatscha, and flows through the little lake of Tal-kirtschin. Its dimensions were — breadth, 7.25 m.; mean depth, 0.998 m.; mean velocity, 0.2168 m.; and volume, 1.57 cub.m. in the second, that is to say, a shade less than the volume of the first kok-ala from the same river. Below this point the Tarim's volume was 54.02 cub.m. — the slight fall which had no doubt occurred since the morning being disregarded. In this region of the inland delta of the Tarim these anastomosing connections between the largest arms of the system are by no means uncommon. Changeable and temporary branches of a similar character can be found in any true river-delta in all parts of the world. The sole difference between them and the Tarim delta is that, while the big rivers on the periphery of a continent are engulfed in the ocean proper, the masses of water which constitute the Tarim are swallowed up in the »ocean» of sand. Notwithstanding this its arms still form a delta which is subject to unceasing change as the years come and go.

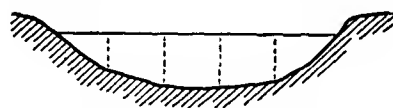


Fig. 176. Right. 0.90 1.41 1.45 1.23 = depth. Left.  
 19 20 22 30 }  
 22 21 25 22 } velocity.  
 25 31 19 }  
 Breadth = 7.25 m. Sejt-uj channel, June 6.  
 Scale 1 : 200.

For some distance below the canal-mouth the river forms none but gentle curves. On the right are two or three unoccupied huts. On the left we observed an old boldschemal, Taman-aktik-köl, connected with the river by a specially made canal, so that the pool within it, which is said to be a profitable fishing-ground, never dries up. At the spot where the lower extremity of the boldschemal strikes the river there are some huts, the former winter-quarters of the people of Sadak-köl, though they are now deserted, since their owners have taken to spending the winter at Tschigelik-uj. The containing banks are as a rule strongly scarped, with almost vertical faces, and up to 3.94 m. in height; they are crowned by magnificent poplar forests, now in jeopardy of being undermined at the windings of the river. One forest-tract on the right bank bears the comical name of Chodai Vär-di-kalmakgha-til-värgen, which being translated means that it is the place Where Chodai Vär-di (standing on the one bank) talked with a Kalmuck (who was on the other bank). Thus a circumstance of the most trivial character suffices to originate a geographical name, which thereupon becomes perpetuated. At an acute bend the tract adjacent

bears the name of Tokta Kullune-köli, pointing to the existence of an abandoned loop hidden in the forest. Immediately below that lies on the left a large boldschemal, abandoned two years ago. At the *örtäng* or *gen-deng* («station house») of Tokum the river used formerly to make another sharp bend, though, luckily for us, it had quite recently deserted it. But it was still full of water, and the station-house was standing on its bank. Hence the people of the station-house, and any travellers who may chance to spend the night there, have to put up with stagnant water to drink, unless they prefer to fetch it from the river. The great highway which accompanies the Tarim from Arghan touches each west-going loop in turn; so at Tokum-tüschkün. Thereupon the river inclines to the east, in long zigzag reaches, leaving the highway behind it. The first bend is called Kavak-asti. But so level is the ground that in places the river flows for short distances towards the north. At Kujusch (the Confluence) the river is joined by another kok-ala without a name, its water just as clear as the water of its predecessors. It communicates with the Tarim by a narrow bottle-like neck, just above which it widens out into a basin. Below the Ilel Kulatscha the eastern stream divides again into two branches. Of these the one on the left, the river proper and the larger of the two, forms the Sadak-köl, while the smaller, the one on the right, goes to Kujusch. Its dimensions

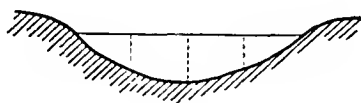


Fig. 177. Right.  $\begin{matrix} 0.99 & 1.24 & 0.95 \\ 24 & 25 & 20 \\ 19 & 19 & 17 \end{matrix}$  = depth. Left.  $\left. \begin{matrix} \\ \\ \end{matrix} \right\}$  velocity.

Breadth=6.20 m. Kujusch, June 6. Scale 1 : 200.

were — breadth, 6.20 m.; mean depth, 0.795 m.; mean velocity, 0.1934 m.; and volume, 0.95 cub.m. in the second. With regard to this stream the same thing holds good that we have found to obtain in the case of the preceding branches: in the autumn it is entered by the water of the Tarim. Formerly this arm used to join

the main stream at the next following loop, were we saw its mouth, then dry. At Turfanlik-ottogho on the left there is a boldschemal; the name indicates that people from Turfan once halted or dwelt there. A similar tale, *mutatis mutandis*, is told by the name Kamschuk-ottogho (Where the Kamschuks Halted), given to a boldschemal about 25 years old, which also bears the name of Chodscha-jaghan-köl. This however contains water, which soaks through from the river at all seasons. After that comes a loop jutting out towards the east, though its days are apparently numbered, and then a dry arik, issuing from the river on the right.

All day long forest was common, and well advanced in growth; and although the roots of the numerous trees lent a certain degree of tenacity to the banks, these were nevertheless seriously undermined by erosion. Here the velocity was as much as 0.60 m. in the second. The river-bed is deep, and has been carved out with extraordinary energy. In fact, like the Ugen-darja, it resembles a dug canal, while the alluvial deposits are confined to very narrow strips, or for long distances are absent altogether.

In those regions and at that season night comes like a friend doubly welcome, as it freed us from both the toils and the torments of the day. As soon as the moon rose, we used to continue our drift with the current, for not only was the air then fresh and cool, but it was purified of the swarms of irritating gad-flies,

midges, and mosquitoes. The banks were illuminated with torches and lanterns, as well as lighted by the moon. The air used to grow perfectly still, not a sound was heard, not a breath moved on the face of the waters. The river before us was shrouded in mist. In the evening light clouds of vapour floated up from the banks, the river, the forest; but at night the heat which had been absorbed was again exhaled all around us, and the air grew deliciously cool. Every now and again the stillness of the night would be disturbed by the crisp rippling of the water as it broke against some piece of driftwood, anchored at the bottom of the stream, while at intervals a big poplar would stretch out its arms over the stream, as its leaned itself far out from the bank. The mighty river, having run its course valiantly, having escaped the threatened perils of the sandy desert, having survived its numerous enemies — evaporation, the aridity of the ground, and the thousands of marginal lagoons which like insatiable vampires suck its blood all the way down — here takes up its swan's song, for the distance it still has to travel to its eternal rest in the desert is now short.

And yet the quiet, peaceful night which I have just described was but a deceitful sign. For as early as three o'clock in the morning we heard two or three violent gusts of wind, sufficient to have set our ferry-boat floating off down-stream, had she not been securely anchored by strong cables. These were the harbingers of a north-easterly gale, a *sarik-buran*, which forced us to lie up the whole of the 7th June, though between 10 and 1 o'clock in the night we managed to travel a short distance by moonlight. The river still continued to be embowered in plenteous forest, and was very serpentine. The only local names I noted here were *Basch-karaunelik* and *Ajagh-karaunelik*, each designating a *boldschemal*. The former had been so long cut off that its pool was converted into a *daschi* or salt lagoon; the latter, being fed from the river at high flood, afforded good fishing. In this locality *boldschemal* was used to signify the abandoned loop, and *jarsik* the pool of water that remains in it; though the same word, or alternatively *jarsuk*, is also applied to the water which is left on the inner side of an alluvial deposit, that is between it and the river-bank (*jar*). A silt bank is called *kajir*.

The gale still continued during the 8th and 9th June, only its intensity increased until it became a *kara-buran*. The features of the landscape were blotted out by the dust-haze, the air became full of fine dust, which in spite of everything we could think of to protect ourselves, such as smoking, penetrated our noses, our mouths, our eyes, while of the gad-flies and midges there was not a trace to be seen. On the 9th June the velocity of the wind did not measure more than 11 m. in the second; but then we were screened by the forest, and in point of actual fact the velocity was very much greater. On the third day the dust-haze was inconceivably thick, so that we were barely able to see the opposite bank; nor had we any longer cause to complain of the heat. To a caravan on the march a storm at that season of the year comes as a welcome relief: it cools the air and frees the poor animals from the clouds of insects which torment them. But to our ferry-boat this *kara-buran* proved an insuperable obstacle: it was dead against her and prevented her from advancing a yard. There was nothing to be done except to wait patiently. According to the information I gleaned from the natives, the spring is

the stormy season, but the summer is comparatively quiet. My own experience is however that the summer is not much better than the spring. We were now in the beginning of June, and yet had a storm of the worst description, lasting over three days; nor was this by any means the last storm of the season.

At sunrise on the 10th June this stubborn tempest at last began to subside, and it soon passed away entirely, and was succeeded by a perfect calm. Sudden and abrupt changes in the atmospheric conditions, from violent commotion to dead calm, or *vice versa*, are characteristic of this region. Sunrise in such a connection is however a mere figure of speech, for all day long we never caught a single glimpse of the great luminary, and there was not the faintest quickening of light anywhere to indicate its position in the sky. The air was still thick with dust, there was a sort of subdued twilight, and we no longer required the darkened spectacles which at other times are absolutely indispensable. Strange to say, a great part of this dust was dispersed in the night. During the night of the 9th it was so far clear abovehead that we were able to perceive faintly stars of the first magnitude. Next morning however the atmosphere was as thick as ever, although the night had been perfectly still. This curious circumstance was somehow connected with the cooling and evaporation of the earth during the night, though it is difficult to determine precisely what was the nature of the connection. On the other hand, it cannot be the warming effect of the sun which lifts the dust higher into the air, for, as I have said, of the sun we did not obtain a glimpse all day long; and the air was full of dust before the sun actually rose. After a few hours of calm the wind once more began to blow.

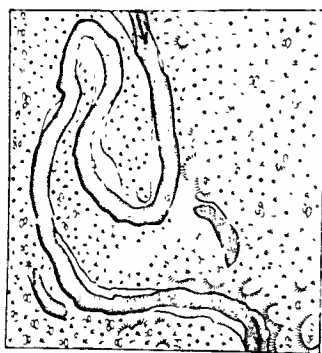


Fig. 178. KARA-GHATIK-JARSIGHI.

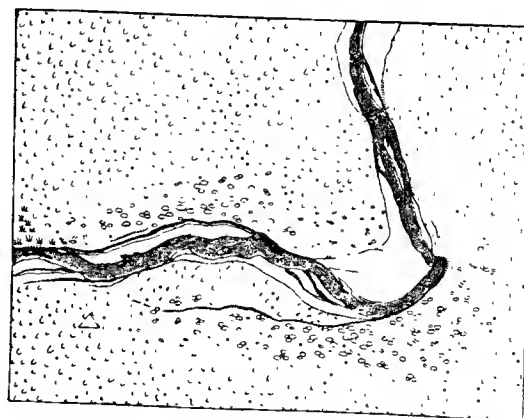


Fig 179. PART OF THE JARKENT-DARJA BELOW DUNG-GEREM, 20 OCT. SHOWING A HIGH BANK ON THE RIGHT SIDE WHICH IS REACHED ONLY BY EXCEPTIONALLY HIGH WATER.

On the right we again passed a so-called *tüschkün* (e. g. a »dip-down» or place where somebody has settled), in other words, a spot where the highway touches or »goes down» to the river. The locality generally is called Tuna-toghdi. Then, after making one acute bend to the east, the river flows tolerably straight for a time, passing Tschökön-otak, one of the headquarters of the hunters from Korla. The banks, especially the concave portions, are still planted with thick,

luxuriant, old forest. Towards the west however the belt of vegetation is only narrow, as I ascertained through a reconnaissance, and the high, barren sand approaches quite close to the river. Except for the tongues of sand which the desert thrusts out towards the forest at intervals, there intervenes between forest and desert a belt of steppe, or, as the natives call it, *tschöl* or *tättir*. On the left we have the boldschemal of Mening-tschökön, containing water, with another similar one opposite to it, but dry. Next comes, on the left, the locality of Tugha-öldi (Camel Died); I was even told that it was a Mongol's camel which fell there. In Jakub Bek's time the Mongol pilgrims to and from Lassa (Lhasa) used to travel along the west bank, in order to avoid the great highway, were they were exposed to the exactions of Jakub Bek and his men, besides being also interfered with by the Tungans. But since the Chinese have had possession of the country, the pilgrims have been able to travel without molestation.

After passing a fresh jarsik we came to the district of Tschimälelik, and beyond it to a couple of sharp bends with a boldschemal, and, on the left, a lateral bed called the Jäkänlik-boldschemal, 35 years old; it contained stagnant water, but is supplied from the river at the period of high flood. At Jäkänlik-tüschkün, where, as the name indicates, the highway again touches the river, there is a little *örtäng*, no longer in use. Below it an arik (now dry) is led off to the *jajlaks* (or »pasture-grounds»). Then the river turns to the east, until it reaches Aschur Bek-tüschken, or Where Aschur Bek Encamped — Aschur Bek, the chief commissioned to lead the Kamschuks northwards, is said to have made a halt here. On the left bank there is a belt of sand,



Fig. 180. JARKENT-DARJA AT KALMAK-KUM, 20 OCT.  
SHOWING JARSIKS ON BOTH SIDES.

planted for the most part with poplars and tamarisks. The great highway, after running close beside the river for a time, again diverges from it, bending towards the south, whilst the river flows on towards the east. In the district of Kara-ghatik-jarsighi, on the other side of an acute bend, there are jarsiks on both sides of the stream. After that the current flows tolerably straight. These two jarsiks of Kara-ghatik might serve to illustrate the difference between the jarsik and the boldschemal; for the difference is more than one of name only, it is rooted in the origins of the two features. A bolschdema is, as I have already explained, a disused loop; a jarsik is generally (like the two here in question) a product of a specially high flood, caused by the river swelling out beyond its usual eroded bank, and forming a new containing bank at a little distance from the usual one. These exceptional and higher



banks are often distinctly perceptible for some distance into the forest. As in these places the river's erosive energy is more active, there results a considerable hollow below the banks, giving them an appearance of more than the usual altitude and substantiality. In the deepest parts of the lagoons there is generally a little pool of water (*jarsik*) remaining until the next high-flood season. Very often it is impossible to determine whether what one sees is a boldschemal or a jarsik.

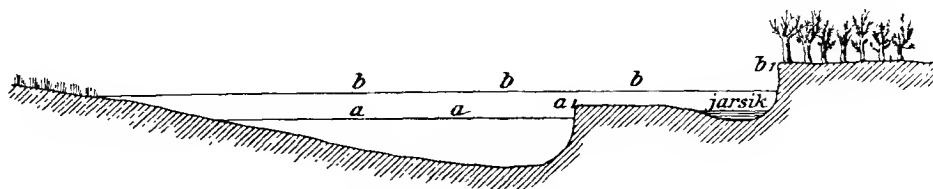


Fig. 181. A JARSIK LEFT A SHORT DISTANCE FROM THE RIVER, WHEN THE HIGH WATER LEVEL, *bbb* HAS FALLEN TO *aaa*.

At the next bend we found a small lake well stocked with fish. Old forest was still abundant, and young forest also was common. At Ketmen-kaldi there is a small jarsik on the left bank, set about with low dunes, and immediately below it yet another. In fact, these formations are very numerous all along this part of



Fig. 182. Right. 0.55 0.54=depth. Left.

144 152 } velocity.  
80 132 }

Breadth = 4.8 m. Upper channel of  
Schirge-tschapghan, June 10.  
Scale 1:200.

For some distance below this point the river flows uncommonly straight. Upon reaching Schirge-tschapghan, we encountered the upper canal, which issues from the eastern chain of lakes. It had there the following dimensions: — breadth, 4.80 m.; mean depth, 0.363 m.; mean velocity, 1.1798 m.; volume, 2.06 cub.m. in the second. On the 18th April this same channel had a volume of 2.44 cub.m. Its hydrographical importance will be analysed and discussed in another connection. Passing Jalghus-jigdedake-uj on the left, and on the right Kurban Supa-tschapghan, Sokuschghan, and the jarsik of Jangi-köl, with its good fishing-grounds, a product of the river's overflow, we pulled up in a loop, the isthmus of which was only a few meters across, conveying the impression that it could not much longer escape its inevitable destiny. The river gave here the following measurements — breadth, 47.23 m.; mean depth, 1.887 m.; mean velocity, 0.6887 m.; volume, 61.38 cub.m. in the second. Thus since the 19th April it had lost no less than 40 cub.m.; for on the date last mentioned I obtained the following measurements — breadth, 47.6 m.;

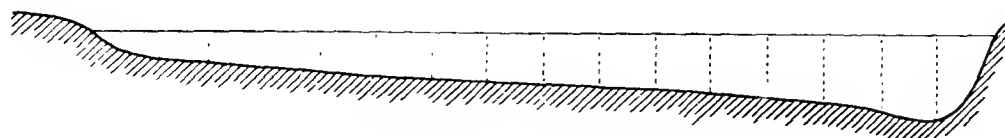


Fig. 183. Left. 1.34 1.55 1.53 2.04 2.18 2.30 2.42 2.46 2.70 2.82 3.07 3.25 3.63 3.93 4.34=depth. Right.

58 87 90 97 88 96 92 86 103 100 113 108 102 100 74 } velocity.  
66 80 90 90 98 92 97 98 106 103 104 106 108 101 81  
51 72 85 80 78 92 88 93 99 101 92 97 97 94 87  
88 102 100 95 97 80 78 }

Breadth 47.60 m. Tarim at the same place, April 19. Scale 1:400.

mean depth, 2.491 m.; mean velocity, 0.8590 m.: and volume, 101.86 cub.m. in the second. Deducting from this the volume of the upper kok-ala, 2.44 cub.m., we have left 99.42 cub.m., which was the true *datum* for the river. The total contributions of the Kara-köl system amounted on the 18th April to 5.15 cub.m.; so that the river below its outfall had a volume of 107.01 cub.m., or 21 cub.m. more than at Jurt-tschapghan a short distance lower down a few days later. Hence, notwithstanding the influx from the Tschertschen-darja, the loss of water in this short stretch was very considerable indeed. It is possible, that a wave of ice-water just happened to pass Shirge-tschapghan on the 19th April; in that case it would soon afterwards make its influence felt at Jurt-tschapghan also. If this explanation is not sound, then the great loss of volume must be ascribed to the Kara-buran and the other lakes in its vicinity, where there is excessive evaporation.

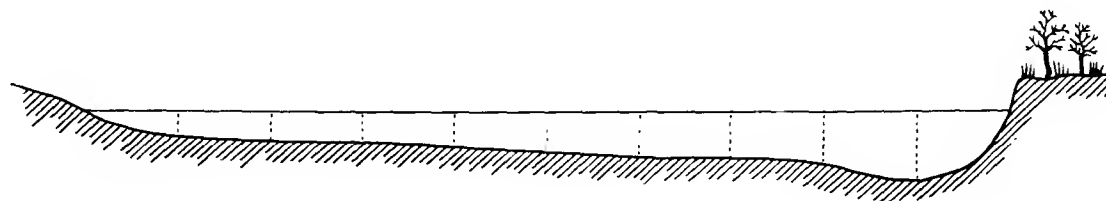


Fig. 184. Left. 

1.20	1.46	1.58	1.83	2.00	2.19	2.36	2.76	3.49
69	77	75	80	99	91	95	90	71
58	63	69	76	84	89	92	85	68
48	57	61	70	75	84	85	72	63
			65	72	80	71	64	50

 Right.   
 } depth.   
 } velocity.

Breadth = 47.23 m. Tarim at Schirge-tschapghan, June 10. Scale 1 : 400.

The section I first measured exhibits a bed of exceptional regularity of formation: the depth increases gradually from left to right, the maximum depth of 4.34 m. being only 2.6 m. from the right bank. The swiftest part of the current does not flow where the greatest depth is, but a little to the left of it. The *data* show also that the velocity at a depth of 1 m. is generally greater than the velocity at the surface. The lower *kok-ala* from the eastern chain of lakes had the following dimensions — breadth, 5.85 m.; mean depth, 0.457 m.; mean velocity, 1.4148 m.; volume, 3.78 cub.m. in the second. Thus this arm of the river had augmented since 18th April, when it had a volume of 2.71 cub.m. The reason the two do not augment and diminish simultaneously may be due to a pure accident, for instance, the fact that the upper channel is partly obstructed by kamisch, broken branches, sand, and silt.

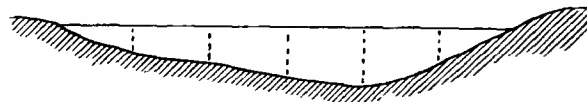


Fig. 185. 

0.39	0.49	0.64	0.76	0.46
148	145	182	163	142
93	132	173	159	145

 } depth.   
 } velocity.

Breadth = 5.85 m. Lower channel of Schirge-tschapghan, June 10. Scale 1 : 200.

June 11th. We passed on the left Karghalik-otak, with boldschemal and lake. The loop at Ak-köl had, I found, undergone a change since I passed it in a canoe in the spring of 1896. On that occasion I wrote concerning it (*Petermanns Mitt.*, Erghft. 131, p. 99). »So macht der Fluss einen fast vollständigen Kreis oder weiten

Bogen und kehrt beinahe auf denselben Punkt zurück; die Landenge wird aber durch einen kleinen Wasserarm durchschnitten; dieser Arm hatte in seiner Mitte einen ganz kleinen See gebildet, Ak-köl genannt. Der Arm war so schmal, dass nur ein Kanoe hätte passiren können. Wahrscheinlich wird der weite Bogen mit der Zeit vom Fluss verlassen und abgeschnitten werden — —; die Geschwindigkeit des Stromes ist in dem kleinen Kanal bedeutend grösser als im Fluss.» Since these words were written, the loop has been abandoned by the river, though its boldschemal, with the exception of a small part near the upper extremity, was still full of water. The two projections on each side of the breach, where the neck of land or stalk of the loop was cut through, still confronted each other, though both were a good deal worn away. The undermining had been, it was evident, greatly facilitated by the little branch which traversed the Ak-köl. This last, together with its connecting link, has of course disappeared; but the name remains, and will no doubt in time be transferred to the boldschemal.



Fig. 186. THE TARIM AT SCHIRGE-TSCHAPGHAN.

Some distance lower down, and on the same side of the river, yet another similar loop has been destroyed. At Boghu-baschi there is an abandoned hut. Thence the Tarim proceeds south for a time, then turns west until it reaches the fort of Kurghan and its örtäng, where it once more strikes the great highway. There in the middle of a loop there is a siltisland, a remarkably rare phenomenon in this part of the river, where there exists no room for alluvium to develop. There is no forest after leaving Schirge-tschapghan; the few poplars which still occur stand isolated and are quite young. On the right we have Toktasin Bek's arik and on the left Aru-akkan, a canal coincident with an old and otherwise dried up bed of the Tarim.

The latter name is pronounced Aru-akkan, and is said to indicate the bifurcation of a branch which has broken away from a larger river; indeed *ara-akkan* properly signifies »the middle river». Then on the right we observed Alim Niase Iiasi-dung and a *jarghan-su*, that is to say, a side-arm which bursts through the characteristic rampart at the side of the river at the time of high water; here too is another arik going off to water the pasture-grounds. The canals on the right of the river have to be kept dammed at the season of high flood, otherwise the water would overflow the high-road. Then come successively Achun-ilesi on the right; on the left Kultuk-tschapghan, an arik that has been dry for two years; on the right Baki Achun-tschapghan and Tschako-tschapghan; on the left the arik of K  k-tschol, supplying a pool and *jajlaks* (pasture-grounds). We encamped on the left bank over against Tschigelik-uj.

June 12th. At the fishing-station of Tschigelik-uj the Tarim measured—breadth, 42.73 m.; mean depth, 2.545 m.; mean velocity, 0.5938 m.; volume, 64.58 cub.m. in the second. At Schirge-tschapghan, after it is joined by the two canals, its volume was 67.22 cub.m. Thus in the space of two days it had diminished by 3 cub.m., partly through diurnal subsidence, partly through evaporation and absorption into the ground. At this same place I also measured the river on 18th April 1896 (see *Petermanns Mitt.*,



Fig. 187. THE TARIM AT TSCHIGELIK-UJ.

*Erghft.* 131, p. 102). The method I then employed was not so exact as that I now used, but the result it gave was 71.6 cub.m., or a little more than on this occasion. Even though this result were only approximately correct, it may be assumed that in 1896 the river carried a less volume than it did in 1900, at any rate in the period succeeding the melting of the ice. But in this connection we must not lose sight of the great and varying effect of the winter temperature. The winter of 1895—96 was nothing like so severe as that of 1899—1900. In the former year there was a less quantity of ice and the flow of the stream was not arrested so effectually as in the latter year, but is continued to flow on regularly all through the winter. The

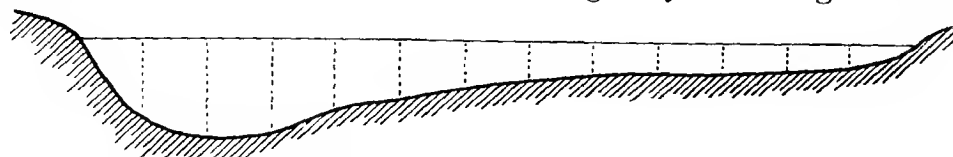


Fig. 188. Left. 

4.03	5.06	4.95	3.64	3.01	2.51	2.12	1.72	1.69	1.57	1.54	1.25	= depth. Right.
54	68	73	75	69	70	69	70	70	58	54	49	} velocity.
70	62	79	71	65	69	63	69	60	43	51	30	
64	70	70	68	62	60	60	56	49	35	47	25	
60	68	69										

Breadth = 42.73 m. Tarim at Tschigelik-uj, June 12. Scale 1 : 400.

*Hedin, Journey in Central Asia.*



Fig. 189. TSCHIGELIK-UJ.

ental type — a deep and rather narrow trench, with a maximum depth of about 5 m. next the left bank, that side of the river-bed being also more deeply eroded than the opposite side.

Tschigelik-uj counted then, in the summer, 11 ujlik of 50 individuals, though in winter there are only 3. The rest of these people spend the winter at Schirge-tschapghan and along both banks of the river from there upwards to Arghan. In addition there were 28 other individuals, who live for the most part at Tscharklik, and grow wheat and other cereals. The village owned at the time of our visit eight *aghils* or sheep-folds, containing 1,100, 1,000, 1,000,



Fig. 191. ANOTHER GROUP FROM TSCHIGELIK-UJ.

volume of the spring flood is almost more dependent upon the winter temperature than upon the amount of the precipitation in the mountains; but this latter circumstance is, on the other hand, the principal determining »factor» in fixing the volume of the autumn flood. For other conclusions I refer to the volume dealing with the meteorology. The spot at which I measured the river in 1896 was a short distance below the spot at which I took my measurements in 1900; but the section of the river I obtained presented on both occasions the same fundam-



Fig. 190. WOMEN AND CHILDREN AT TSCHIGELIK-UJ.

800, 500, 400, 300, and 150 sheep respectively, or a total of 5,250 sheep, belonging to the bajs of Tschgelik-uj, Tokus-attam, Tschaj, and Tscharklik. Each *aghil* owned also 5 to 15 cows, and 5 to 10 asses, as well as 25 horses divided amongst them.

During the night a violent wind got up, bringing with it haze and drift-sand. It continued all the following day, though not quite so violently, all the next night, and all the 14th June, when it again blew with its original violence. During the ensuing night, between the 14th and 15th June, it rained

in quite a lively fashion, and in addition to the dust the atmosphere became filled with a thick mist. On the evening of the 15th the sky cleared or nearly so, and the temperature dropped to  $+9^{\circ}.3$  C., an exceptionally low reading for the middle of the continental summer which obtains in these parts. The wind, which now came from the N.  $45^{\circ}$  E., was less regular on the 17th and 18th, blowing in squalls at frequent intervals. By this the gale had lasted 6 days and nights almost without interruption. Although the phenomena connected with the winds are treated in the meteorological part of this work, I have nevertheless alluded to them briefly in passing, because of the important rôle they play in modifying the physical geography of the country. Not only are the hydrographical relations dependent upon them, but also in a high degree the distribution of the sandy desert.

During my former journey it rained on the 17th and 18th April at Tokusattam; at the same date in 1900 it rained again at Kum-tschapghan; and now the same thing was happening at Tschigelik-uj. According to my experience therefore, the rainy season falls here in the end of spring and the beginning of summer, though even then rain is of rare occurrence and the precipitation small in quantity.

June 19th. At Tschigelik-uj we had a maximum depth of 5.06 m., and the same depth and same breadth still continued to characterise the river, which, sharply scarped and outlined, was here flowing almost due south. I noted growing on the banks reeds and grass, a thorny bush (*kongortschak*), tamarisks, a solitary poplar about 20 years old, and a dozen others in a clump which might possibly be twice that age, as well as an occasional *jigde* bush about a score of years old. Immediately below Tschigelik-uj a small artificial canal goes off on the right, and then a little way below it a natural watercourse. These two, after uniting, run to the village of Lop, and thence on to the Semilaku-köl; the volume of water which

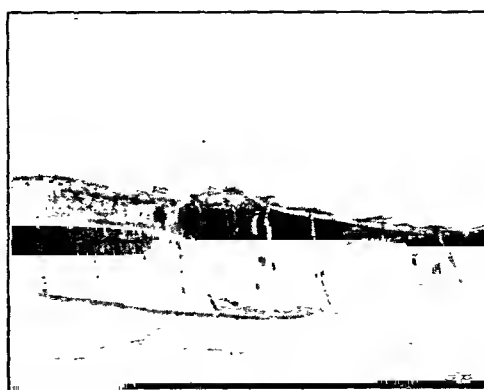


Fig. 192. STABLES AT TSCHIGELIK-UJ.

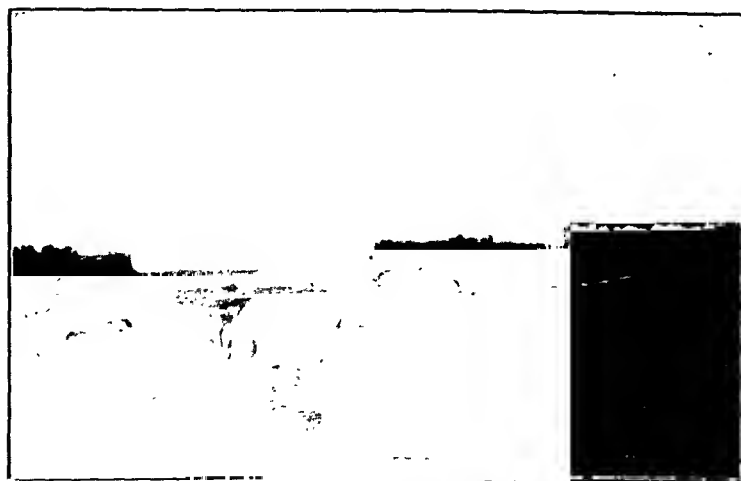


Fig. 193. CATTLE AT TSCHIGELIK-UJ.

flows this way is said to have materially decreased during the last eight years. From the left an arik, now dammed, is led off. At Jilik-otak, on the opposite bank, another artificial canal goes off to an unnamed lake, and then, joining itself to the Lop branch, enters the Semilaku-köl. While there is low sand, held together by vegetation, on the left of the river, there is none at all on the right. It is a belt of *alakum* or *partscha-kum* lying

immediately contiguous to the river; east of it, all the way to the edge of the drift-sand, there is said to extend *tättir* and *täkäs-jer*, or »level ground».

Next we passed on the left a fifteen-year old bed of the Tarim, then dry; this rejoins our waterway at Tokus-attam, a village which thus stands on a strip of land between the Tarim and the branch that forms these lakes. It is evidently the masses of deposited sediment which constrain the river to convert itself into lakes, and *vice versa*. The stream, hitherto deep and narrow, divides here and becomes shallow, flowing sometimes through thick, luxuriant kamisch, sometimes amongst bare silt-beds, and finally issues into the Schukurne-köli. This lake is sparsely overgrown with *jäkän* (sedge), and is extremely shallow, so shallow indeed that it was as much as ever it would do to float our triple canoes. At the end of the lake we entered a narrow watery passage amongst the reeds, and here came in from the right the branch from the old bed of the Tarim which I have mentioned. Indeed the little water strait amongst the reeds is said to have once been itself a bed of the Tarim. The current in it was painfully slow; in the lakes no current at all was perceptible. At Scharkurun — a name indicating either that rapids are formed there at the time of high flood or existed there formerly — the current again became livelier. There were no rapids at Scharkurun at the time of our visit. After that we crossed over a little lake called Kok-ala-köl. On the whole the distribution of the water here was pretty much the same as it was in 1896. The village of Tokus-attam still occupied the same position, and still numbered 5 ujlik (15 individuals); in addition there were eleven other families then living in Tscharklik.

The 20th June was a bright day, with a brisk breeze from the north-east; and though it blew away the fine dust, it was not keen enough to clear the air of the swarms of gad-flies. Our route lay through a series of shallow lakes, all overgrown, and through narrow *tschapghans* or channels cut through the dense reeds, in which there was often a very lively current. The first lake was Üsüm Kulludaschilik, of whose shore we never obtained a glimpse, so dense were the reeds. This we crossed towards the south-east, but after that we steered towards the east. In Kötsch Kullu-köl, which nowhere exceeds 3 dm. in depth, no movement of the

water could be detected. The kamisch was extraordinarily dense as well as extraordinarily vigorous, but the *tschapghans* were for the most part cut through the *jäkän* (sedge), no doubt because it is easier to keep the passages open through sedge than through kamisch. The water was clear and the lake bottom consisted of bare sand; I failed to observe any Algæ. The depth increased a little, though it still remained less than 1 m. In the Ojman-köl there was a very extensive piece of open water. Kalmak-ottogho, on the other hand, with its meandering channel, can only be described as a close and sweltry marsh. This name, meaning the Dwelling-place of the Kalmucks, is said to go back to a time when the locality was dry

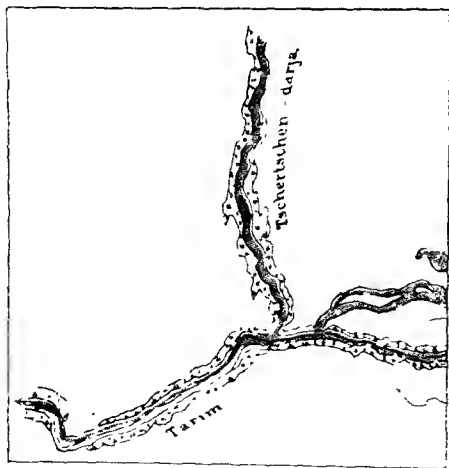


Fig. 194. CONFLUENCE OF THE TSCHERTSCHEN-DARJA WITH THE TARIM.

land, and the Kalmuck (Mongol) pilgrims used to make it a halting-place. We still continued our uncomfortable journey through these shallow and densely overgrown lakes. One of them bore the name of Julghunluk-köl or the Tamarisk Lake. Immediately south of our route lay Tschaj, with 8 ujlik and 51 inhabitants, to whom must be added 48 more who live at Tscharklik during seed-time and harvest. In 1896 the same village counted only 6 families, but at the present time it is considered to be the largest village of any in the lower Tarim lake district. At Semilaku-tekgen the alluvial deposits stretch a long way in every direction, though principally towards the south. Beyond that point the river gathers itself, as it did in 1896, into a deep, narrow channel, bordered on both sides by belts of reeds growing upon pier-like ramparts or embankments of silt. Outside of these the country consists chiefly of mud-flats, in places still wet, and inclosing occasional islands of kamisch, though every now and again this is interrupted by extremely shallow sheets of water. This is what remains of the lake of Kara-buran, which covered such a wide area in Prschevalskij's time. Since his visit the lake has continually shrunk in area, though it still becomes filled to some extent at the period of high flood. By the middle of August it is said to be completely dry, not even one abandoned pool being able to survive through the summer. But from the middle or end of October, when the autumn flood reaches this quarter, it gradually fills again.

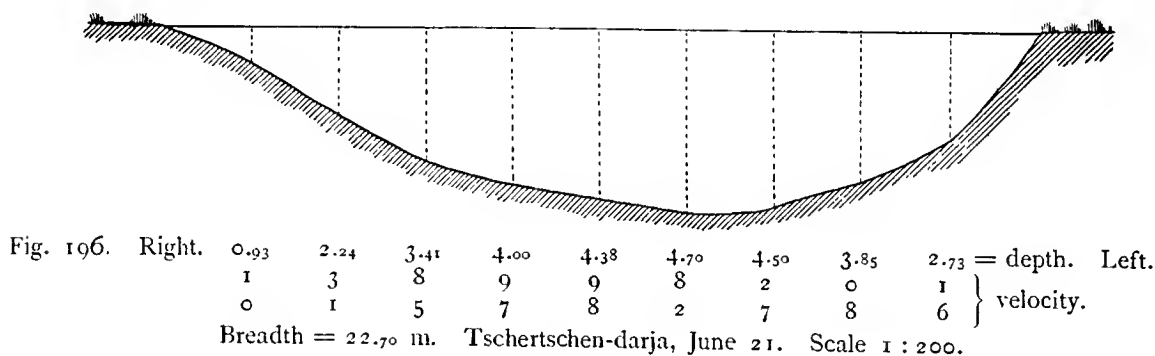


Fig. 195. NEAR THE MOUTH OF THE TSCHERTSCHEN-DARJA.

We were now close to the confluence of the Tschertschen-darja. This river, which approaches from the S. 20° E., presents precisely the same appearance and the same characteristics as the Tarim in the same neighbourhood, and like it flows through a sort of corridor or avenue of kamisch, while on both sides stretch horizontal deposits of sediment. Although it appeared to be a powerful stream, its current



moved so extremely slowly that we had much ado to measure it at all. Its dimensions were — breadth, 22.7 m.; mean depth, 3.074 m.; mean velocity, 0.0499 m.; volume, 3.48 cub.m. in the second. Thus at this season the Tschertschen-darja contributes less than 4 cub.m. of water to the lakes of Kara-koschun. The natives asserted that in the middle of May an alteration took place in the lowest part of the Tschertschen-darja's delta. During the preceding winter this stream found its way to Lop past Basch-aghis (see below). At the present time it pursues a more westerly course, and leaves its bridge 3 or 4 km. away from its left bank. This change was declared to be caused by the mouth of the Basch-aghis getting choked with mud, whereupon the river flung itself over to the south and then to the west. After the passage of the *mus-suji* («ice-water» or «spring freshets») the Tschertschen-darja had this year swollen to an unusually great size. When the autumn flood comes, it enters the Tarim through a large number of *aghis* («mouths», «confluences») of different sizes; but of these only one, the biggest, mentioned above, contained water at the time of our visit. The two arms of the Tschertschen-darja, the old one and the new one, unite in the Semilaku-köl. The inhabitants of Tschigelik-uj and Tokus-attam assert, that the volume of the Tschertschen-darja has been constant for as long as they are able to remember, whereas the volume of the Tarim has been every year growing distinctly less, and this circumstance they attribute to the recently formed arm of Schirge-tschapghan (Tokus-tarim), which is described in a later chapter of this volume.



The section of the Tschertschen-darja is in every respect peculiar. The river-bed has been cut deeply and energetically through the perfectly level alluvial formation. Even when at the low stage, the water lips the brink of the trench in which it flows, so that a very slight augmentation would cause it to overflow. It may be assumed that the stream is both active and powerful at the season of high flood. The delta of the Tschertschen-darja is very changeable, and its constituent arms frequently alter and shift from one place to another. The growing tongue of low alluvium at the union of this stream with the Tarim seems to be pushing the confluence farther and farther towards the east. And low though the alluvial delta-land is, the water nevertheless has there a not inconsiderable fall, which of course helps to intensify its erosive power. Considering the incessant changes to which this deltaic region is subject, it is matter for surprise that the river-bed is so distinctly marked as it is. Indeed, precisely the contrary might have been expected, namely that the river should cease to flow in a well-defined channel, but become split up into a number of shallow

deltaic arms, gradually decreasing in volume as they divide; in a word, one would look to find the water spreading out over the flat land like the ribs of a fan. After all it is not so strange, that the water does fill the bed flush with the brim, for the lowest part of the river-bed serves as a sort of reservoir or provisional lake, which is kept filled by the constantly flowing water, small though that may be in quantity.

In April 1896 the Kara-buran contained a great deal more water than it did in June 1900; but in April 1900 the quantity must have been very appreciably greater than in the corresponding month of 1896. The bend which the river makes after receiving the Tschertschen-darja had not changed during the four years, and was still fenced in by the same alluvial barriers and the same narrow belts of reeds, though the alluvial deposits alongside it were for the most part dry. The locality on the left bank is known as Sejt-uji; formerly there was a village there, but it was deserted ten years ago. Just below this point the river is joined by a channel from the Semilaku-köl, which however only carries water in the autumn. The region, consisting of low dunes with tamarisks, which stretches northward from



Fig. 197. REEDS ON THE BANK OF THE TSCHERTSCHEN-DARJA.



Fig. 198. MOUTH OF THE TSCHERTSCHEN-DARJA.

Basch-kumluk, or the Beginning of the Sand, is no longer inundated, not even by the autumn flood; though in places the river-side is bare, pointing to recent overflowings. On the south of the river there is no sand, and here inundations still occur sometimes. All day we only passed two poplars, standing close together and about 10 to 15 years old. If only the river could maintain its existing channel for a sufficient length of time, its banks would, beyond doubt, become clothed with luxuriant forests similar to those which exist beside other older portions of the Tarim. The very absence of forest here points indubitably to a formation of the river-bed so recent that there has not yet been time for forest to grow up. If it be objected, that it is *impossible* young shoots and seed should grow up here, seeing that they would have to force their way first through the lakes of Kara-buran, where they would be arrested by the dense reeds, I would reply, that such *à priori* reasonings are deceptive; for, while we should expect to find forest on at least the older shores of Kara-buran, these are as a matter of fact perfectly bare of trees.

Immediately above Tschirak-tschantschghan we passed the mouth of the easternmost deltaic arm of the Tschertschen-darja, containing perfectly stationary water. Here

too was a *tüschkün* or point of contact between the river and the great highway from Abdal to Tscharklik. The ground on both sides of the river there is firm and settled, and is no longer exposed to inundation. Then we have, on the left, Ejša Kullu Aksakal-ottogho, and on the right Tadschini-ottogho. The »ford» of Kätschik is no longer practicable, the stream being too deep, even when running at its lowest. Beyond that the river flows unusually straight as far as Ghun-körük\* (pron. Ghun-köjuk). At Tschakullalik there is a very sharp bend.

We encamped just above Badschit-tschantschdi, whence, as far as we were able to see to the north, the country was bare and free from sand, flat as the surface of a lake, except for an occasional tamarisk growing on its peculiar root-mound; in all probability it is a region that was formerly under water. The depths all the way from the confluence of the Tschertschen-darja were very considerable, the deepest soundings obtained being 4.20, 3.40, 3.20, 4.06, 4.80, 5.14, 4.98, 3.45, 4.03, 5.43, 3.75, and



Fig. 199. GROUPE OF NATIVES AT JURT-TSCHAPGHAN.

4.25 m., and then on the farther stretch down to Jurt-tschapghan 4.85, 5.23, 4.10, 4.0, 5.24, 4.75, 5.15, and 3.10 m. The breadth was remarkably uniform, and the alluvial deposits, where there were such, nothing more than the thinnest strips along the convex banks.

On and after the 21st June the only names I noticed were Jangi-köl, a now dry tract on the right bank, though formerly inundated; Jaruk, with an *ile-dung* or »signpost-hill», that is a mound with a pole stuck in it, beside the road to Tscharklik; Muren-ajaghi, where the brook of Muren or Mian used formerly to enter the river

Tujdale; Kitschik-atscha, a small river-branch of older date, on the left; Kujghu-tschapghan, a canal watering some pasture-grounds on the right. After passing this last we perceived ahead of us on the right bank the characteristic crenelated walls of the fort, partly in ruins, and the huts of Jurt-tschapghan, also known as Basch-uj. Over against these we pitched our camp. A short distance below Jurt-tschapghan the river finally empties itself into the marsh of Kara-koschun. This last section of the stream will be described when dealing with the marsh — in Vol. II.

\* This word means »deep mud lagoon», not »sun-bridge», as I, misled by an erroneous explanation, have stated in *Petermanns Mitteilungen*; I was then under the impression that it was a corruption of Gun-kobruk.

# THE LAKES BESIDE THE LOWER TARIM



## CHAPTER XVI.

### RELATIONS BETWEEN MARGINAL LAKES AND DUNES. — BAJIRS AND DUNE-MOVEMENTS.

It was on the 6th and 7th December 1899 that I passed the first links in the chain of curious lakes which stretches along the right bank of the Tarim after it turns to the south-east, or generally speaking along the stretch between Karaul and Arghan. These lakes are in every respect of such a strange and uncommon character that at the first glance it is impossible to understand how they can have originated, or how the contours and the hydrographical relations of the region can have contributed to their formation. One would naturally suppose that, the river here washing the feet of sand-dunes 90 m. high, this would be precisely the last quarter in which to look for the creation of lacustrine basins. And yet it is in this very locality that we find a continuous series of lakes possessed of a depth greater than we find in the river itself immediately adjacent. I have investigated and sounded some of these accumulations of water, and will now proceed to describe them in order, and thereafter deduce the conclusions which are directly suggested by the ascertained facts.

But before proceeding to discuss my own experiences, I ought to state first what was already known about these lakes, and it is not very much. The only traveller who has visited the region is M. V. Pjevtsoff, though he can only have seen these dunes at a distance. What he says\* about them is as follows: »South-west of the Jarkent-darja extends the lifeless desert which the natives call Kettek-schaari-kum. It is covered by gigantic accumulations of sand, lying almost north-and-south, and between them are sandy expanses, consisting of low, flat *barkhans* which resemble waves of the sea. The stupendous sand-ridges approach in several places almost to the very brink of the river, though in other places they are as much as 10 versts from it; everywhere however they are plainly visible from the road. It is not so very long since the wild camel used to frequent this desert and the natives to hunt him in the autumn and winter, but 10 years ago he disappeared and took up his habitat elsewhere. The last wild camel is reported to have been seen amongst the sand south-west of the village of Jangi-su. The native hunters are of opinion that these wild animals have travelled southwards down the lower

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\* *Trudij Tibetskoj Ekspeditsij 1889—90*, vol. i. p. 324.

Jarkent-darja (Tarim), and thence made their way up the Tschertschen-darja to the stony, sandy desert which extends south-west of the locality of Vash-schaari, where it is commonly reported that the wild camel is still to be found in large numbers.»

The information which Pjevtssoff gathered from the natives with regard to the desert lakes is as follows (pp. 326 ff.). »The inhabitants of the region described live principally by fishing, only in part by agriculture and hunting. They take their fish almost entirely in lakes artificially made in the depressions along the river-banks, and fill these natural depressions by means of canals, 150 to 1,200 saschen long, which were dug by their ancestors. All these lakes have been full of water for many years, with the exception of the Ettek-bair, a lake about 8 versts in circumference, which was only filled in 1886. In the same locality there are counted a dozen such lakes, seven large ones and five small ones. They all lie on the right bank of the river, and their shores are overgrown with tall reeds. The largest lake, Jangi-kul, is about 15 versts long, by 2 versts broad, and its depth amounts to 3 saschen. The next largest, Basch-kul, is 12 versts long, 1 verst broad, and 3 saschen deep. The area of the other five large lakes is only about one-half the area of Jangi-kul; while the five small lakes measure each one to three versts in circuit.

All these lakes are cut off from the river, though each has communication with it by means of its inflow canal, but outflow they have none. All the inflow canals are stopped with earthen dams, and are only opened periodically to let in fresh water from the Jarkent-darja just before the autumn floods. The inflowing currents bring with them into the lakes large quantities of fish; as soon as the river begins to drop, the canals are closed and the fish retained in the lakes. Water is let into the small lakes every second year, and into the large ones every third or fourth, and in some cases every fifth, year. In the year when water is not let in the volume of the lake decreases a little, and its water acquires a slightly brackish flavour, and with each year that the lake remains without a fresh inflow the salinity increases, until in the fifth year it is extremely bitter, and very disagreeable to the taste. Notwithstanding this great salinity, all the species of fish that exist in the Jarkent-darja — *Nemachilus yarkandensis*, *Aspiorrhynchus Przewalskii*, *Schizostorax Biddulphi*, *Diptychus gymnogaster*, are found in these lakes. The lakes are divided amongst the inhabitants of the adjacent villages, each lake having its recognised owners, apart from whom nobody else has any right to fish there.» And then follows an account of the way in which the fish are caught.

This description applies to 1890. Since then a good many of the inhabitants have adopted agriculture as a livelihood, and several of the lakes alluded to have been abandoned to their fate. In the next few pages we shall see what the country looked like ten years later.

The first lake is the Teis-köl, which differs from its sister-lakes in not being immediately surrounded by desert sand. Above this there are said to exist two depressions, Ettek-bajir and Kaltschini-bajiri, though neither contains water. Thus the first real desert lake is the Tus-alghutsch-köl, connected with the river by a canal (dry on 7th December) which winds through the reed-beds and has a hut beside it. This lake is said to be now kept cut off from the river, even at the time of high

flood, owing to its mouth having been stopped up with branches, brushwood, and clay. The fish which are imprisoned in it are said to become fatter and to acquire a better flavour after the water has in great part evaporated, and the rest of it thus become slightly salt. In the winter the fish are taken in nets let down through holes hewn in the ice, the fish being driven into them by the men stamping and jumping on the frozen surface of the lake. In the summer the fish are caught from canoes. The lake, which is entirely surrounded by high barren sand-dunes, is said to attain a depth of three fathoms (*kulatsch*)\*. Nine families, who formerly dwelt on its shores, abandoned their huts in 1892 and flitted over to the left bank of the Tarim in order to carry on agriculture. The name Tus-althutsch-köl conveys implicitly an indirect explanation: it means the Lake whence People fetch Salt. Possibly its shores are saliferous. In area the lake is very small, and on 7th December it was entirely frozen over.

The next lake is the Sejt-köl, connected with the river by three canals (*utschu* or *aghsi*), now stopped up. All three canals have forced their way through the sand-dunes, though the immediate banks of the middle one and the lowest are quite flat and overgrown with reeds. The lowest, when open, turns a mill. The northern portion of the lake lies for some distance parallel with the river, and so close to it that the two upper canals are each only a couple of hundred meters long. But, as was well seen from the top of the dunes, not far short of 100 m. high, on the east shore of the Sejt-köl itself, the larger portion of the lake extends S. 27° W., and resembles a fjord penetrating between mountains of sand. A long way off we observed a *bughas* («neck» or «contraction») between two projecting headlands, and beyond that a fresh expansion, terminated towards the south by relatively low sand-dunes.

Strange to say, the natives everywhere asserted, that the lakes are »artificially made». According to them, long, long ago canals were dug, and these were widened by the high-flood water, and in this way the depressions, which already existed amongst the sand-dunes, became gradually filled; and in part the sand was even thrust back by the encroaching water. This simple explanation can of course only be partially correct. That the depressions have not been artificially made is perfectly self-evident; they existed indeed before the Tarim ever flowed through that part of the country. That they have been filled, and are kept filled, with water from the Tarim is equally clear, and will shortly be sufficiently proved on the basis of exact measurement. On the other hand it is not likely that all these connecting channels have been made by human agency; it is more likely that the river, by shifting to the right, and in consequence of its overflowing, has carved paths for itself into the depressions. But of this more later on.

At the foot of the vast accumulation of sand on the east shore of Sejt-köl there is a village of the same name, but its huts, built of poles and kamisch towards the end of the seventies, now stand empty and deserted. The twenty-three families who inhabited them flitted, like the twenty-five families of Teis-köl, to Ak-tarma, on the great highway, in 1892. The reason of their changing their habitations was an outbreak of small-pox (*tschätschäk*), which raged in this district

\* A *kulatsch* is the distance between the finger-tips when the arms are stretched out at full length,



and decimated the inhabitants. The same visitation having ravaged all the villages alongside these lakes, the survivors were ordered by the Chinese authorities to flit over to the left bank of the river, and devote themselves to agriculture, especially the growing of wheat, and to pastoral pursuits, more particularly the breeding of sheep. Previous to that they had lived almost entirely upon a fish diet, and by fishing. The soil does not however appear to be very favourable for cultivation, and the harvest does not yield sufficient for the people's needs. This is indeed strange, for one would think that in this locality of all others the irrigation of the fields would not be attended with any special difficulties. Although a few well-to-do families own as many as 1,000 sheep, most of them possess barely 100 each. As a rule they have to procure part of their supplies of flour from Korla, purchasing it by the barter of their sheep. The deserted villages are not occupied even in summer; the people, who are few in number, are still afraid of infection, although they are said to have been vaccinated by the authorities. When the former villagers visit the lakes for the fishing in the summer, they prefer to spend their nights in the open air; for fish still continue to form an essential part of their food, indeed without it they could not exist. The inhabitants of the whole of this region call themselves Loplik, i. e. people from Lop, just as the inhabitants of Kaschgar and Tschertschen call themselves respectively Kaschgarlik and Tschertschenlik. It is precisely in this region that the ancient name of Lop has ineradicably rooted itself.

Generally speaking, the dunes do not advance right up to the shores of the Sejt-köl, but are separated from them by a narrow strip of ground overgrown with reeds and tamarisks, with an occasional poplar. Thus the ground upon which the dunes stand lies somewhat higher than the level of the lake, though on the other hand it is to be noted that the lake has been shrinking and its *niveau* falling since its feeding-canals have been closed. Although the depth is said to reach 4 fathoms, it is as a rule much less. In the northern part of the lake there are some small sandy islands. The lake was frozen over from end to end, but it was only along the shores that the ice bore. The north-eastern shore of Sejt-köl was studded with a great number of small, shallow pools. To ride from one end of the lake to the other took a horseman, whom I sent there at a later date, an hour and a half of hard riding. Beyond and in the line of the lake's south-south-west continuation he discovered three depressions, separated from one another by »thresholds» of sand.

Immediately east of Sejt-köl there is a very small lake, or more correctly speaking a marsh, called Aghesi-köl, after the Loplik who is said to have dug the canal which feeds it. The immediate environment of this little marsh consists of flat ground, with reed thickets and several small pools, though there are no high dunes.

Daschi-köl is divided by a large sandy promontory into two basins of equal size. On the north the lake is separated from the river by a considerable accumulation of sand; and its eastern half is connected with the river by a canal. The dune which bordered the lake on the north-east has been attacked and undermined by an entering loop of the river. Midway in its crest there is a gap or gateway, as it were, the sand having been completely washed away, and through it we had from the river a striking picture of what one might be called a »lacustrine hall», its floor a polished

sheet of ice and its walls yellow sand-dunes. Even in the sound that connects the lake with the river several sandy islets cropped up above the ice, together with some poplars which formerly grew on firm ground at the foot of the dune-wall. The artificial canal has thus lost its importance; but that it used to be dammed is plain from its name, *daschi* meaning »salt-pool». At the present time the lake forms, so to speak, a lateral expansion of the river, and being at the same level with it rises and falls as the river does. When the rush of the spring freshets comes, the water pours *unchecked* through the broad connecting sound into the lake, until it fills it to the brim. A comparison between the breached dune-wall of Daschi-köl and the big sharp elbow north-east of Sejt-köl indicates clearly in what direction the erosive energy of the river is working in the latter locality. The shape of the loop, and the arrangement of its silt deposits, are alone sufficient to show that the river is pushing towards the south-west, and gradually washing away the sand which bars its path. There is already a distinct cavity perceptible, and it may safely be affirmed, that the portion of the sandy neck which has already disappeared is greater than the part which is left, and that it will not be long before this last is completely cut through in the same way as at Daschi-köl. If, when this happens, the Sejt-köl were to be cut off from the river for two or three years, until its level very sensibly dropped, then as soon as the river established a direct connection with the lake, it would discharge a vast volume of water into the latter, and so suffer a serious »blood-letting» before the equilibrium of level was secured between the two. It is only when this step has been accomplished that the water flows freely in and out in the way it did at Daschi-köl on 7th December. There the river did not lose a drop of its water; it was rather the lake that was the loser, in consequence of the river's slow, gradual fall. The same phenomenon is repeated lower down at each of the other lakes, but in the case of none of them is the true situation so distinctly seen as here at the Daschi-köl. The summit of every dune afforded an especially vivid and instructive view of the river's victorious struggle against the dunes. The strip of land between the river on the one side and the Sejt-köl and Daschi-köl on the other is extremely narrow, and even yet narrower the dunes which overhang it. When these last have been finally swept away, it is very probable that the river will shift its bed a good distance to the right by directing its path through the lakes. Then the lakes will be gradually filled with silt and levelled up, except for the trench which the main current carves out for itself through the alluvial deposits. In this way these lakes facilitate the transference of the river-bed towards the right, that is towards the south-west. Except when the stream thus suddenly flings itself into some lake, or series of lakes, the movement of its bed towards the right takes place very slowly, but none the less surely, along the whole of its course. When the river thus violently changes its bed, it might perhaps be supposed, that a portion of the dunes which have been breached would still continue to remain *in situ* on the left bank of the Tarim. In reality however that happens very seldom; at all events there are no independent, detached dunes on that bank of the river. Indeed on that side there is no sand at all, except Igis-dung and a few other fragmentary patches, all of which have been already mentioned. Nevertheless it is quite conceivable that formerly there were such dunes at several places, but they have been blown away

after they ceased to receive fresh accessions of material from the east. One thing however is incontestable, that the dune-length, throughout the entire stretch under consideration, rises steeply, is square-cut in vertical section, and faces north-east, looking out over the almost flat delta of the lower Tarim in the same way as the façade of a row of houses confront the quay in a seaport town.

On 20th December I visited the Tana-baghladi-köl, or the Lake cut off by Tana (properly however »closed» by Tana). The canal connecting it with the river finds its way through the thin *kamisch*, which covers the narrow strip of land that intervenes between river and lake. The high dunes on the east of the lake do not plunge directly down into the river, but have at their foot a narrow strip of firm clay, partly sprinkled with bushes, and partly set with low dunes bearing a few tamarisks. At intervals there occur quite young poplars, probably twenty to thirty years old. Along the right bank of the Tarim there are two or three frozen pools, as if left in memory of the last high flood. This lake is oval in shape, with its main axis extending from south-south-west to north-north-east, but in its morphology it resembles generally the large lakes which will be described presently. It is short and of small size, and is embedded amongst very high dunes. Along its south-east side there is a strip of level ground only a few meters wide, in some places indeed not more than two meters in width, with a narrow belt of *kamisch*, which however is interrupted wherever the dune abuts directly upon the water-line. On this side too the dunes plunge down towards the lake at the steepest angle of which they are capable, whereas on the north-west they have gentle slopes. In this latter quarter, again, the strip of firm sand is broader, and consequently the belt of reeds is also broader. The north-eastern angle of the lake is studded with a number of islets, all more or less overgrown with *kamisch*, and both there and on the south-east the shore is indented by several little bays.



Fig. 200. VERTICAL SECTION OF TANA-BAGHLADI-KÖL.

At the time of my visit Tana-baghladi-köl was covered with a sheet of bright, dry, glassy ice, 2 dm. thick, sloping up at the outer edges and hollowed like a saucer in the middle, an indication that the surface had fallen somewhat since the ice was formed, probably as a consequence of the water being absorbed into the ground. Towards the east side of the lake the water underneath the ice appeared to be dark; there the depth goes down several meters and the bottom is not visible.

The next lake, Talei Kullu-tschapghan resembles the Tana-baghladi-köl in both shape and size, and occupies a precisely similar position amongst the sand. The name is, as usual, not without significance. The word *tschapghan* is a participial form, and means both »dug» and »digging», but when used as a substantive it means a »canal». The compound name does not however necessarily mean that Talei by digging gave origin to the lake, but only that he regulated its natural connecting canal and modified its course.



*Ljustr A B Lagrelius & Westphal.*

VIEW LOOKING WEST FROM THE TOP OF A DUNE-ACCUMULATION.

In the Background is the Northern End of the Seji-kol, and behind it the Windward Slope of the next Dune-accumulation.  
On the Right is the Taim, with Alluvial Deposits and Drift-ice.



On the 12th, 13th, and 14th December I made an excursion to the lakes of Basch-köl and Jangi-köl, which I will now briefly describe. My starting-point was the village of Jangi-köl, inhabited by about twenty families, and consisting of kamisch huts disposed in two rows, together with two houses of clay (adobe), situated close beside the lake's inflow canal. Formerly this village is said to have stood on the shore of the Basch-köl, but was flitted many years ago. In 1892 eleven of the inhabitants of the village died of small-pox. The canal in question is a cutting in the ground 4 m. deep. The mass of solid ice that filled its bottom was 4 to 5 m. broad, but the channel itself varied between 20 and 50 m. in breadth. At the first glance it appeared more than doubtful whether it was of artificial origin, because, owing to its great breadth in places, the labour of digging it would have been enormous. The mouth of the canal, at the Tarim end, had, I was told, been stopped up for ten years, and the water which lay frozen on its bottom had found its way in by infiltration through the sand. Every year however a second and smaller canal is opened for a time, to let in fresh water, otherwise the fish would all die. Even as it is, the water of the lake is perceptibly salt. My guide, Pavan Aksakal, an old man of sixty, and the oldest inhabitant of the village, assured me that originally the canal was dug, but had been widened to its present dimensions by the inflowing river-water. Pavan's father used to fish in the lake, but after he ceased to do so, the lake, which had obviously been cut off from the river, gradually dried up, until about the year 1860 its bottom was an arid waste, though a few poplars and some kamisch grew round it. About 1880 Pavan and his associates spent three years in digging out the canal again, and the first high flood which came after they had finished filled the lake-basin. In 1890 they once more closed the canal, and since then have made a good thing out of the fishing.



Fig. 201. THE CANAL OF BASCH-KÖL.

The greater part of the lake was covered with a thin sheet of ice, which only just bore the weight of a man in the narrow parts and close round the shores. Broad expanses in the middle were still unfrozen, the water being of a beautiful light blue, and as bright as crystal. Ducks and swans were swimming about on these open expanses, and on the shores were partridges, hares, and foxes, besides traces of wild-boar, though these creatures, I was told, only frequent the reed-brakes in the summer. On both sides the lake is shut in by lofty dunes, which thus give it the appearance of a fjord. Close along the margin of the water there is a belt of level ground, consisting partly of fine silt, partly of saliferous sand, soft in summer, though at the time of our visit frozen. Ten years ago this strip of ground is said to have been under water, as indeed was plain to see, and if the canal were to be now opened, it is supposed that the lake level would rise the height of a man, or about 1.6 m. Inundated ground of this description is called *schor*, a word which connotes the presence of salt. Between the strip of *schor* and the desert sand there occurs a belt of thick luxuriant reeds, seldom more than 50 m. broad, generally indeed not so broad; and the lower slopes of the dunes are thinly dotted with tamarisks. Poplars are few and far between, most of those which do occur being on the west shore, where the dunes have a gentle ascent; on the east side they rise at an angle

of  $33^{\circ}$ . Dry tamarisks, probably smothered by the sand, are common at the southern end of the lake. In two or three spots on the east shore there exist wells, which are made by the shepherds in the summer; but the water they yield has a saline flavour, though not so strong, it is said, as the water in the lake itself. Sometimes the inhabitants of Jangi-köl graze their sheep around the shores of Basch-köl, though more frequently they go to the Kontsche-darja.

Oblong in shape, Basch-köl measures 15.9 km. in length and 1.345 km. in breadth, its minimum breadth being one km. and its maximum 2 km.

On the south-south-west the lake is bordered by a gigantic »saddle» of sand, from the top of which one can perceive, farther on in the same direction, a *bajir*, or »depression», which is not more than 1 km. long, and  $1\frac{1}{2}$  km. broad. In the middle this consists of moist *schor*, though sparse scrub grows round its margins. It is cauldron-shaped, being surrounded on all sides by steep dunes of immense size, so that it resembles a former lake-basin into which the drift-sand has failed to penetrate. Upon first beholding one of these strange depressions, embosomed amid the sand-dunes, one is amazed that it was not long ago filled up level with the adjacent country; instead of which one finds that its bottom is not only free from sand, but actually in places moist. As however the depression is elongated in shape, like the lake, and lies exactly on the line of continuation of the latter, it is evident that the two must bear some intimate relation to one another. Beyond this *bajir* of Basch-köl there is nothing but an inextricable chaos of dune-crests, a perfect »sea» of sand, where, notwithstanding that some few of the dunes have an equally steep descent on both faces, indicating the prevalence of winds from two directions, it is yet possible to make out a certain degree of regularity, such as could only result from the prevalence of wind from one settled quarter. At the first glance this regularity is perceived to consist in the equal intervals at which the dune-accumulations lie from one another, the intervals appearing to be shorter than those which I observed between the similar swellings of sand in the heart of the Taklamakan Desert in 1895.

Upon directing our steps towards the east, and climbing to the summit of a dune-accumulation which was at least 100 m. high, we had a more extensive view of the



Fig. 202. JANGI-KÖL LOOKING NNE. FROM ITS SOUTHERN THRESHOLD.

unique and fantastic scene. Along the line of continuation of the Jangi-köl we perceived three big depressions, stretching towards the south-south-west. Even thus early I was convinced of the striking parallelism which characterises the morphology of these depressions. Each of the three I am speaking about was separated from its neighbours by a low ridge or threshold of sand. Towards the north-east extremity of the bajir that lay next to the Jangi-köl there was a little starved vegetation. On the west side of the Jangi-köl there were yet three other bajirs, while to the south there was reason to suspect the existence of a whole series of similar depressions; such at least was the implication suggested by the steep faces of the dunes rising on the east side of the bajirs.

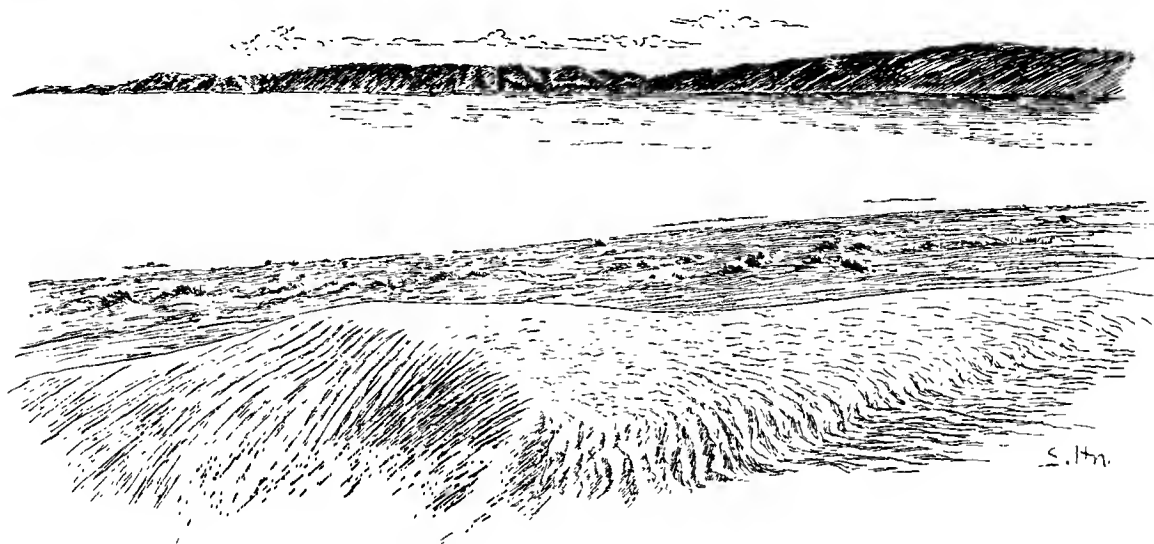


Fig. 203. SOUTHERN PART OF JANGI-KÖL LOOKING NE. FROM LOWEST PART OF ITS THRESHOLD.

From the top of the dune, we directed our steps towards the first bajir of the Jangi-köl, which was rectangular in shape, lying far down below at our feet. The floor of this depression consisted, curiously enough, of a series of concentric zones of varying breadth. On the outside, next the sand, came first dry dusty soil, so loose that the camels dropped into it to 1 dm., whilst the dust whirled up in clouds of the finest and lightest powder. Every now and again through this pulverulent soil there projected pieces of cemented saliferous sand or schor as hard as a stone. The next concentric layer on the inner side of this consisted of soft, moist mud, in which the camels would have been engulfed, had we let them venture upon it. Then came a ring of snow-white salt, encircling a pool of open salt water, dotted round with several smaller pools — the deepest part of the bajir. On the northern margin of this salt pool there grew a patch of thick kamisch, 2 to 3 m. high, and about 100 m. across, and through it ran the fresh tracks of wild boar. That is to say, the only place in these bajirs in which vegetation exists is the part adjacent to the nearest lake. Upon reaching the southern foot of the saddle which parts the Jangi-köl from its first bajir, we had at once ocular demonstration of the way in which the salt pools in the latter originate. For we perceived springs of fresh water bubbling out of the sand and running off in tiny rivulets towards the pool, where the water, in consequence of the incessant evaporation, becomes exceedingly salt. It is therefore fair



to suppose that, as the level of the Jangi-köl rises and falls from year to year, and from season to season, so this bajir lagoon correspondingly expands and contracts its area.

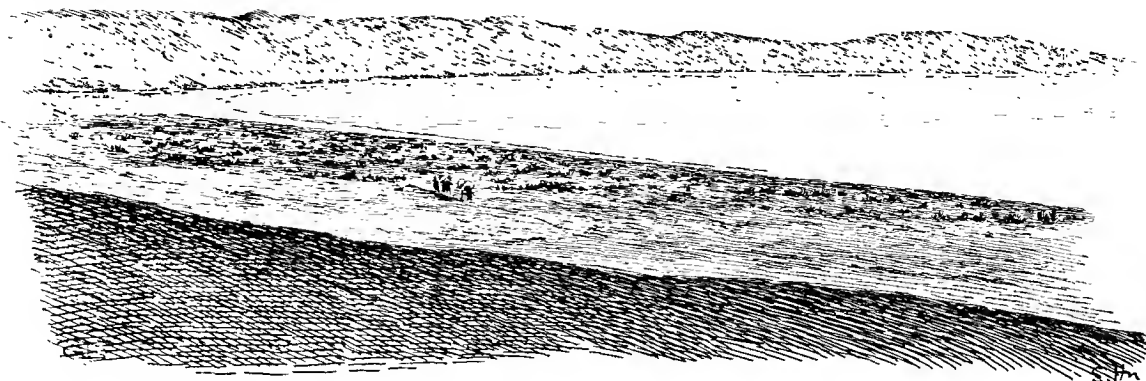


Fig. 204. SOUTHERN PART OF JANGI-KÖL LOOKING NW.

The threshold of sand which separates the Jangi-köl from its first bajir is narrow and only 25 to 30 m. high, and is in part overgrown with kamisch. Viewed from its summit, the Jangi-köl, like the Basch-köl, resembles a fjord, long, narrow, and straight, wedged in between two ranges of yellow drift-sand. The dunes on the south-east of the lake descend very steeply, leaving room at their foot for merely a very thin strip of ground, sparsely planted with tamarisks and kamisch. The lake in that part is said to be at most 4 or 5 fathoms deep, and its water to be perfectly fresh. On each shore we counted perhaps a dozen poplars, of quite tender age; as is usual with this tree, they appeared to thrive in the sandy soil, especially as they had no lack of water. Owing to the distance, and to the fact that the atmosphere was not quite clear, we were unable to distinguish the belt of flat steppe which in the north-east separates the lake from the river, so that the view before us exactly resembled that which distinguishes an oceanic fjord. The level expanse of glassy blue ice formed a most effective contrast to the towering sand-dunes which closed it in on all sides. The long steep dune-accumulation



Fig. 205. ICE OF JANGI-KÖL. VIEW TOWARDS THE NE.

which rose on the eastern shore of the lake was then, it being morning, in deep shadow, and etched its image with astonishing distinctness upon the glittering sheet of ice below. This last, in consequence of the tension created in it by the changes of the temperature, and the process of freezing, whistled and groaned unceasingly. At the south end of the lake the ice curled at the edge, and out in the open parts there were little ridges running across it, and cracks, shining white, in places, as though the ice had been subjected to lateral pressure. The dunes on the west of the lake ascend



*Lynstr. A. B. Lagrelius & Westphal.*

VII. VIEW FROM THE SAME POINT AS IN PL. 38, BUT LOOKING S. 29° W. ACROSS THE SEJT-KÖL.

In the Background is the *Abdus* between the Northern and Southern Basins of the Lake. On the Left, i. e. the Eastern Shore of the Lake, the Photograph shows how the Steep Leeward-sides of the Dunes are situated, whereas on the West Shore the Dunes have a Gentle Slope up to the Next Accumulation, shown in Contour in the Upper Part of the Photograph on the Right.



gently by steps or terraces, like those on the corresponding side of the Basch-köl. This latter, notwithstanding that it has been dry longer than the Jangi-köl, and that its water is now salt, possesses a richer vegetation than its neighbour.



Fig. 206. CURLED UP ICE ON THE SOUTH SHORE OF JANGI-KÖL.

We travelled along the west shore towards the north-north-east. On the whole it is very straight, and its outline regular, except in the north, where it is diversified by small peninsulas, islands, and lagoons. In two or three places we observed the canoes which the people use for the summer fishing. The entire surface was frozen over, except for two or three open places in the extreme north, possibly due to the fact that water there oozes through from the river. Next the shore the ice was 10.2 cm. thick, but only 3 cm. at a distance of 60 m. from the shore. It was as bright as glass, so that we were able to watch the shoals of fish as they swam along, and the Algæ at the bottom, as distinctly as though they had been in an aquarium. The Jangi-köl is fed by three small canals, all at that time closed. It was cut off from the river two years ago, and is to remain in that condition for seven or eight years more. In spite of this the natives declare, that even in that long period the water will not acquire any very sensible degree of salinity, owing to the fact that the Jangi-köl is an older lake, and deep, whereas the Basch-köl has been periodically dry, and is also shallower. In all probability the difference between the two lakes in respect of salinity admits of another explanation. The water which the Jangi-köl loses by evaporation and absorption into the ground is replaced by fresh water filtering in from the river; whereas the Basch-köl occupies a firmer and less permeable bed, and loses most of its water through evaporation.



Fig. 207. VERTICAL SECTION OF JANGI-KÖL.

Between the two lakes I have just mentioned lies the smaller lake of Uja-köl, with its canal called Uja-köl-aghesi («mouth»). There is also another lakelet, known as Motel-uktusu (*uktu* = «little lake»), situated close to the river at the north-east foot of the dunes. The Jangi-köl apparently belies its name, which means New Lake, for the people declare that it is the oldest lake in that locality. The Basch-köl, the Upper Lake (e. g. Head Lake) derives its name from the fact that it is the first in the series, or lies higher up the river than the others do.

Even this short excursion was sufficient to teach us certain characteristic features with regard to these lakes, and to show us that the physical geography of the region is governed by certain definite laws. The marginal lakes lie on the same side of the river as the drift-sand, that is on the right bank, and are connected with the river by means of canals. They lie parallel to one another, and are long and

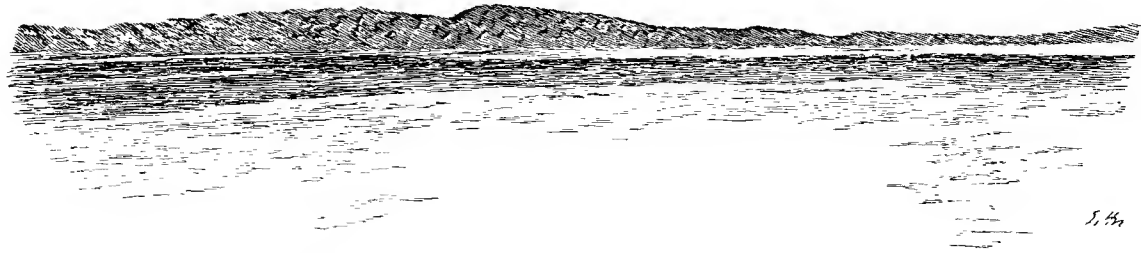


Fig. 208. THE WESTERN DUNE-RANGE OF JANGI-KOL.

narrow, with their major axis stretching from north-north-east to south-south-west. In continuation of each lake, but separated from it by a low saddle or ridge or threshold, is a bajir or depression in the sand, of precisely the same form as the lake-basin, the only difference between the two being that the bajir is without water. The elliptical, concentric arrangement of the mud, schor, and salt in the bottom of some of the bajirs proves that these once contained water. The fact of their being dry shows also that they lie a step higher in altitude than the mother lake, otherwise they too would be filled with water. Finally, the sand-dunes which border each lake and bajir on the east present towards them a steep slope, while the dunes on the west have a gentle ascent. From all this it is not difficult to infer that the surface features of the country, and its other physical characteristics, are determined by the prevailing wind; but to this problem I shall return again presently, after setting forth a richer mass of material for consideration.

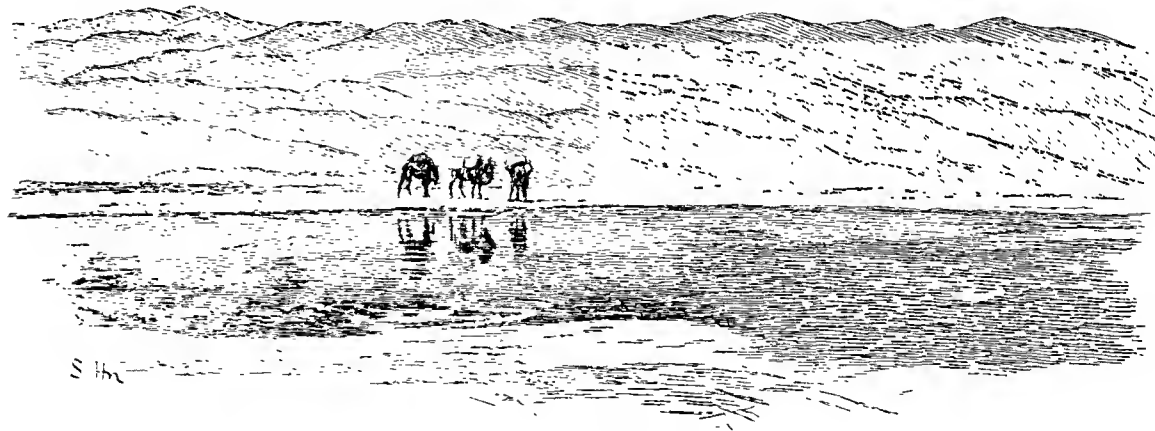


Fig. 209. PART OF THE WEST SHORE OF JANGI-KÖL.

The most convenient time for investigating these lakes would have been in mid-winter, when the ice bears, and when it would have been possible to take soundings through holes chopped in it. But just at that particular season I was otherwise engaged, and in the beginning of winter the ice only bears at the outside round the shores. The second occasion on which I had an opportunity of visiting the lakes, namely the month of May, was quite as inconvenient, though for another reason, namely it is then that the east-north-east sand-storms rage with the greatest severity, making it perilous to venture out in the small narrow native canoes. This was the cause of a trip which I took to Gölme-käti on 18th May proving unsuccessful — unsuccessful that is in so far as soundings were concerned. We did obtain



*Ljustr. A. B. Lagrelus & Westphal.*

VIEW OF THE EXTREME NORTH END OF THE SEJT-KÖL, TAKEN FROM THE LOWER DUNES SHOWN  
ON PL. 38, JUST ABOVE THE FERRY-BOAT.



a few, it is true, but they were too close to the shore to afford any idea of the general bathymetrical relations of the lake, or of the relief of the lake-bottom. This failure was not however of any real consequence, for other subsequent trips, which were favoured with better fortune, proved that these sister-lakes, which hang on the Tarim like leaves along a stalk, are all exactly like one another, so that what is true of one is true of all. After mapping two or three of them with minute exactitude, and becoming familiar with their general relief, one may, without risk of serious error, construct bathymetrical curves of the others, provided the draughtsman is already familiar with their contours.

On 18th May 1900 Gölme-käti, the Lake of the Lost Fishing-net, was cut off from the Tarim by a dam put down in its connecting canal, and situated 133 m. from the river. From that point to its issue into the lake, or 620 m., the canal contained sufficient water to allow of our paddling the canoes. The storm compelled us to keep to the eastern shore, where we obtained some shelter under the steep dune-walls. Along the line we in that way followed the depth increased as we proceeded from north to south, and the greatest depth was obtained quite close to shore at the extreme south end of the lake. Under the west shore the depth was less. Along both shores were a few small clumps of poplars, rather young, as well as some of the usual tamarisks and kamisch. The strip of flat land bordering the lake on the west was considerably broader than that on the east side. There too some of the tamarisks were actually growing in the lake, as though the lake were slowly advancing westwards, for these bushes do not of course take root except on dry land. It might be supposed perhaps that they grew up at a time when the lake-level was still lower than it was on 18th May; but, on the other hand, it is to be remembered, that at this date the lake was actually at a low level, for it was then cut off from the river. I do not of course pretend that these tamarisks growing in the water are a *proof* that the lake *is* travelling westwards. On the other hand, it is quite natural that the greatest depths should be found under the eastern shore, for in reality the lake is nothing else but a dune valley, or more correctly a valley between two dune-accumulations. The dunes which overhang its eastern side plunge steeply down to the maximum depths of the lake, and thence the bottom shelves gradually upwards towards the shore-line, and so farther, in like manner, up towards the crest of the dunes which shut in the lake on the west. There cannot exist a shadow of doubt but that the dune »waves» are advancing, though at an extremely slow rate, towards the west. Hence it may reasonably be assumed as likely, that the lakes are also subject to a movement in the same direction. The dunes will not of course allow themselves to be for one moment arrested by stationary water; they have no choice, they *must* continue moving westwards. Every storm that comes — and these storms blow with unexampled violence, — scoops the sand up from the windward side of the dunes and deposits it on their summits, whence it trickles over to the leeward side, so that in this way the eastern shore of the lake is gradually being pushed westwards. Similarly on the west side of the lake, the wind scoops up the loose-lying sand, beginning at the very edge of the water, and lifts it to the top of the next wave in the desert ocean, which thus wave by wave marches irresistibly westwards. In process of time these lakes are bound to disappear. We have seen that



the strip of flat land, bearing vegetation, is broader and less steep on the west side than the corresponding strip at the foot of the dunes on the east of the lake. The western strip not only *is* broader, but it must grow broader, in consequence of the westward movement of the dunes on that side. Assuming however that the lake preserves its existing level, then its western water-line will be but little altered, owing to the ground being bound together by the vegetation which grows on it, and in that way being made more resistant to the wind. Thus, while the western dunes travel away from the lake, and the strip of firm ground at their feet grows broader, the dune-wall on the opposite or eastern side of the lake approaches continually nearer to the west shore, and at the same time the eastern shore-line, which, because of the prevailing winds, is more changeable, gradually advances westward. The lake thus grows narrower, for the eastern dunes advance faster than the western; finally the two opposite shores will melt into one, after all the irregularities of the lake's circumference have been already filled in. Thus the statement, that these lakes travel westward, is only true up to a certain point; for, as the dune-wall on the east continues to advance without let or hindrance, the entire lake must eventually be filled and levelled up with drift-sand. Hence the fact of tamarisks growing in the water on the west side of Gölme-käti is a mere chance circumstance, the lake having probably, like the Basch-köl, at some time or other contracted, though, it is true, the natives are ignorant of any such occurrence. It would only need a subsidence of one meter, and then, when the canal was again opened and the lake-basin again filled, the ground on which the tamarisks stand would become inundated — to their eventual destruction.

If now, as I have assumed, the eastern dune-wall is travelling towards the west, that is across the lake, one would expect its sectional area to present the appearance shown in the accompanying fig. (210), that is to say, the dune to plunge straight down into the lake without step or break, for at every storm the sand is brushed over the crest, and must therefore roll down the steep leeward side to its base. When however we find, as an actual fact, that the sectional area presents the appearance depicted in fig. 211, we are at first sight disposed to question the

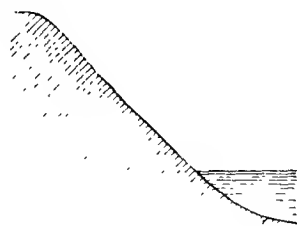


Fig. 210.

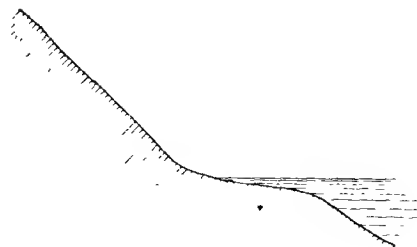


Fig. 211.

fact of the westward movement of the dunes. The step, or shelf, with an inclination of  $2^{\circ}$  or  $3^{\circ}$ , which we see extending both above and below the water-line, while the leeward side of the dune descends at an angle of  $32^{\circ}$  or  $33^{\circ}$ , is in reality nothing more than an abrasion terrace. In respect of breadth it varies greatly. In sheltered spots it is sometimes only two or three meters broad (above the water), but in more exposed situations, capes and headlands, it swells out to a breadth of 50 meters and more. In fact, considering the levity and buoyancy of the dune-sand, the presence of an abrasion terrace of this character is precisely what might be expected. Suppose now that at a given moment the dune occupied the position *a-a*, (fig. 212) and the surface (*W*) of the lake were in complete equilibrium, then the first wave impact against the base of the dune would produce a sand-slide from above, the

descending sand would disappear beneath the surface of the lake, and the sectional area would assume the appearance shown in *b—b*. This is what happens on every rock-bound coast, though on a larger scale and at an immensely slower rate. No matter, then, whether the dune travels fast or travels slowly towards the west, there must always be an abrasion terrace accompanying it and sharing in its movement. On the whole its

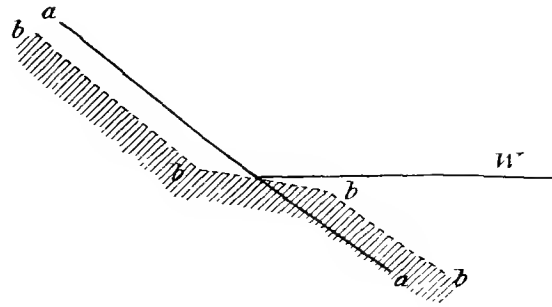


Fig. 212.

breadth will be pretty uniformly the same, for the selfsame force which causes the dune-wall to encroach upon the shore-line is also instrumental in widening the abrasion terrace and »preserving» it, that is to say the wind. So long as the atmosphere is at rest and in equipoise, no change takes place, but as soon as the wind blows, the waves, both of the lake and of the desert sand, are set in motion. But while the lake waves widen the abrasion terrace by their beating, the sand-waves continue their movement towards the west.

Every impartial and unprejudiced observer who should approach the east shore of the Gölme-käti, when the wind is perfectly still, would at once say, without a moment's hesitation: Here the prevailing wind blows from the east. Of course the wind does sometimes blow from other quarters as well, for example in the end of December 1899 and beginning of January 1900 it blew from the south-west, but these winds are relatively feeble and of no account as compared with the violent easterly tempests. If the winds from any other quarter except this last were possessed of any real power, the abrasion terrace on the eastern shore of the lake would not, and could not, exhibit the uniform breadth it does. Under the impulse of a south-westerly or westerly wind the waves of the lake would increase the breadth of the abrasion terrace, and the dune, if it were not prevented altogether from advancing westwards, would at any rate have its advance retarded. The surface modelling would be entirely different, irregular, wanting in definiteness of outline. As it is, however, the relief is so sharp-cut and so distinct that there is no possible room for doubt. What we have before our eyes suggests instantly the power which has been instrumental in shaping the features of the landscape. The reason the eastern abrasion terrace is so narrow is that it lies under the shelter of the dunes, and consequently the lake there is relatively tranquil, while the east wind compels the dunes to travel on over it. Nevertheless there is always a certain degree of undulatory movement of the surface of the lake, which, cooperating with the disturbance caused by winds other than the east wind, is sufficient to maintain the terrace. The most energetic wave-action in a lake like the Gölme-käti is exercised however on the west shore, where the effects produced by a spring storm are very conspicuous, especially in the crumbling away of the shore under its attacks. All the loose material which lines the shore is sucked back into the lake by the receding waves, though the opposition offered by the vegetation and its roots prevents the destruction from being so complete as it otherwise would be. It is true, detached pieces of the reed-beds are occasionally rent away, and a solitary tamarisk or two, after the circumjacent

movable soil has been washed away, has its roots from time to time submerged; still, on the whole, the vegetation offers a decided resistance. At any rate the lake-basin is being filled by the dunes advancing from the east, while at the same time there is no power which is able to hollow out and deepen simultaneously, and to the same extent, the already shallow western part. The advance of the dunes and the extinction of the lake are illustrated by the subjoined fig. (213). At the present time the lake is situated between the two dune-ranges  $a-a_1$ ; when it has advanced as far as  $b-b_1$ , its area will be reduced one-half, and by the time it assumes the position  $d-d_1$ , its basin will be entirely filled up by the sand which pours down the leeward side of the eastern dune-range. If J. K. stands for Jangi-köl, then its basin will of course undergo the same metamorphosis. Now, on the assumption that the dune  $a$ , masks a depression in the surface, then, in proportion as the existing lake of Gölme-käti disappears, this depression ( $X$ ) must gradually emerge, and become converted into a fresh lake.

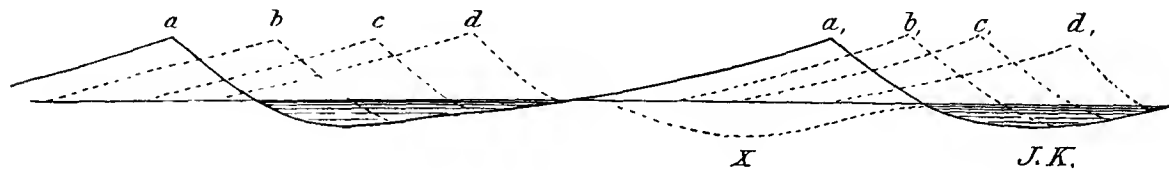
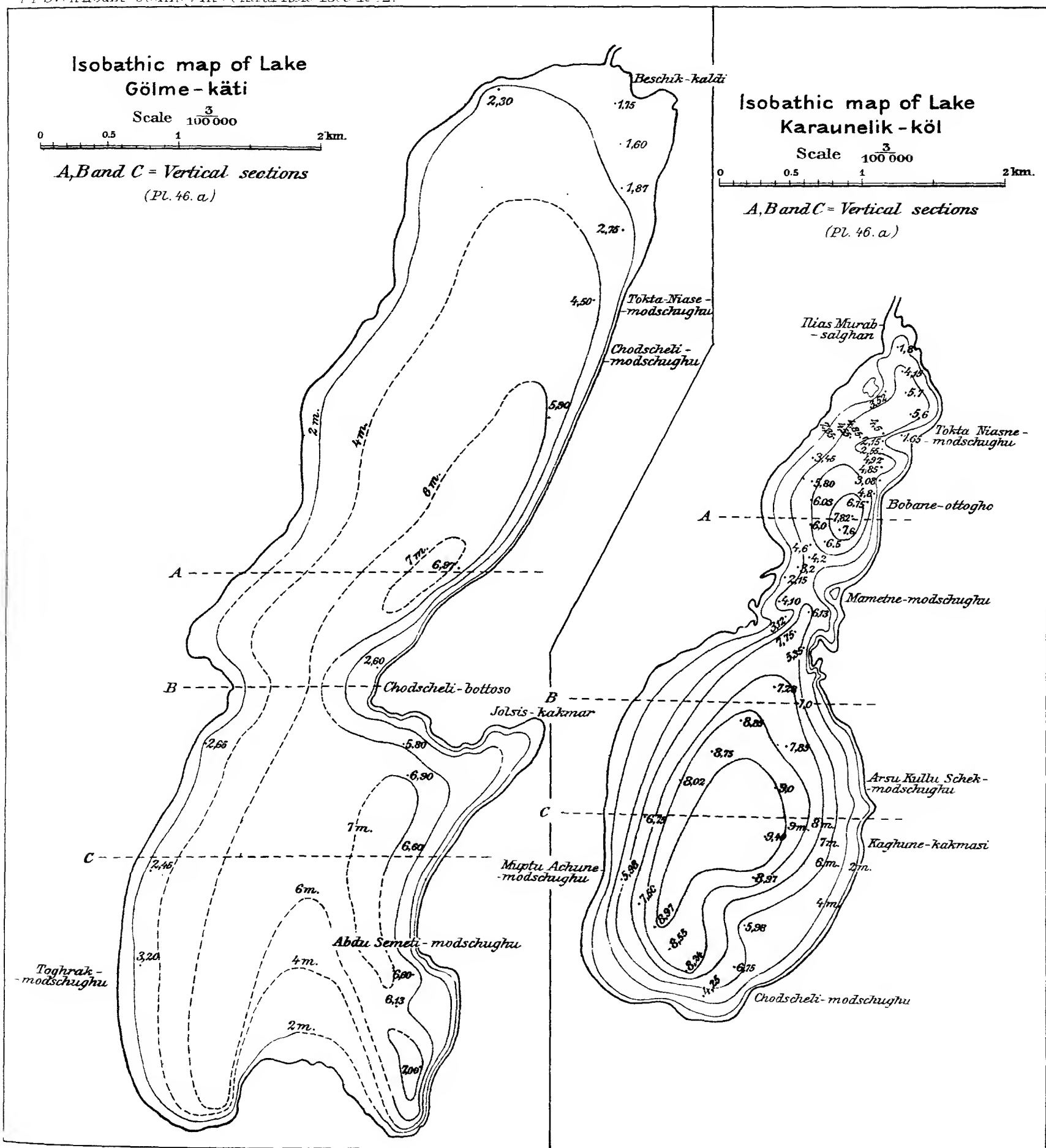


Fig. 213.

Now it is possible that a critic, starting from the existence of the belt of vegetation on the east shore, might question the correctness of this migratory theory. If that shore is uninterruptedly moving westwards, how is the presence not only of kamisch and tamarisks to be explained, but also of poplars, which, young though they are, would hardly be able to strike their roots in ground possessing so little firmness as this. When the dune has travelled from  $a$  to  $b$  (see fig. 214), the poplars which grow on the terrace must gradually be buried under the sand, and be killed. And this is just what actually does take place, for the belt of vegetation on the east shore of the lake does not of course possess any power to prevent the sand from advancing. Indeed we frequently find poplars half buried in it, only the crown and a portion of the stem being visible above ground. Poplars in such circumstances are extremely stubborn and tenacious of life. It is as though their branches struggled with concentrated energy to offer the utmost possible resistance to the destructive element, striving to persist in the air as long, and drink in as much sunlight, as they possibly can, before having their vital spark extinguished for ever by the annihilating sand. Thus the narrow belt of vegetation on the eastern shore is unceasingly threatened, and possesses no power of either postponing or warding off its inevitable destiny. Upon a closer investigation we find also, in the case of all these lakes, that the belt of vegetation on the east shore is much narrower, as



Fig. 214.





well as sparser, than the belt on the opposite shore, and also that the former generally lies at some distance from the edge of the water, whereas the latter actually touches it. This in itself is a clear proof of the westward migration of the dune-waves.

That vegetation does exist on these sandy desert-like shores is not at all to be wondered at. All three varieties — poplars, tamarisks, and *kamisch* — thrive excellently well in sandy soil, provided only their roots go sufficiently deep to tap the groundwater. All three species are found a long way into the Desert of Takla-makan. In 1896 I noticed clumps of living poplars all the way from the point where the Kerija-darja dies away in the sand, to the Tarim. The seed is carried to the shores of these lakes by the water flowing in through the open canals, and once there it finds all it needs, water indeed in far too great abundance. Probably the reasons why poplars are not more plentiful there, and do not form dense forests, are that the dunes do move westwards, and that the lakes are sometimes cut off from the river, and at such times their water tends to grow salter.

I never saw, beside any of the lakes I visited, ancient poplars similar to those which exist in the forests of the upper and middle Tarim; here they are seldom more than fifty years old, generally far younger. And what is the reason of this? Simply and solely this, that the river, to which both lakes and vegetation alike owe their existence, is a new-comer in that particular locality. When the river flitted over into its existing bed it is impossible to say; but lower down I shall be able to prove by inexpugnable and unmistakable data that it cannot have occupied its existing channel for any very great length of time. Of course I do not mean to assert any such thing as that the river's tenure of its present quarters, along this particular section of its course, is to be measured by a space so short as fifty years or so, though that is not at all unlikely; indeed in the case of some of its loops one might without rashness assign a much younger age than even that. I will merely say, that if the river had flowed along its present channel for several centuries, the poplars which are now standing, for instance, on the west shore of the Gölme-käti, would be far more developed, and would bear plain indications of a more mature age. Then there is also this pretty obvious fact to be borne in mind, that tho poplars of the east shore would be almost certain to be overwhelmed by the sand, before they had an opportunity to attain any very ripe age. Thus, once more, the thinness of the vegetation, as well as its youthful age, are both governed (1) by the fact that the river itself, which has filled these lacustrine basins, is such a comparatively recent creation, and (2) by the fact that the dunes do migrate westwards.

If, then, the river is a recent arrival in this locality, what did the country look like previous to its advent? So far as its morphology is concerned, precisely as it looks now (Pl. 47). The only differences are, that the previously existing depressions have been filled with water, and that vegetation has sprouted in what hitherto was a perfectly barren region. Nor are these mere guesses; they are deductions from the observations I made, and the experiences I underwent, in the interior of the Tschertschen Desert. Equally certain it is, that the flooding of these depressions does not exercise the slightest effect upon the movement of the dunes in the direction of the prevailing wind. In fact, these elongated lakes occupy precisely those portions of the sandy desert into which the power of the wind does not reach, that is to say,

they form the valleys amongst the dunes, and so are screened from the effects of the wind. Nor does it make any difference whether they are filled with water or with sand. No matter what the constituent content of the valleys may be, it is the windward flank of the western dunes which continues to be assailed by the wind and the sheltered flank of the eastern dunes which continues to advance before it. It should also be borne in mind, that the volume of the lake, and its other dimensions, are relatively insignificant as compared with the mass of the migrating dunes; for while the dunes tower up to 90 m. in altitude, the lake is at most only 11 m. deep (see below, for the maximum sounding). Although the proportion of its mass which the dune loses in its passage across a water-filled depression of this character is indeed high, still that fact does not in any way affect the dunes' movement *per se*. It is an irrefragable proof of the correctness of this assumption, that as the continuation of each lake we have a bajir which is destitute of water. For if the water really were a hindrance to the migration of the dunes, each bajir would advance at a more rapid rate than the dunes which overhang its associated lake on the east, and would not lie, as it actually does, in a straight line with the lake.

At the end of some centuries, when the dunes have travelled over the three or four kilometers which now make up the breadth of the lakes, and have filled up their basins with sand, the intervening space or valley between the dunes *a* and *b* will consist of flat arenaceous soil, that is, assuming there is no depression concealed under the dunes *b*. The ultimate result therefore of the operative agency of the dunes is to level the face of the country by filling up all its hollows and depressions. If we assume that the river will maintain its present position for a sufficient length of time, the lakes too will disappear, and if, as we have already seen, the Tarim is advancing irresistibly to the right, that is towards the south-west, their fate is even more certainly sealed. Hence the results which I conceive to have been established by the preceding investigations are these: — (1) the lakes are to all intents and purposes stationary; (2) the westward movement of the eastern lake-shore is conditioned by the corresponding migration of the dunes on that same shore; (3) it is the movement of these last which fills the lake-basins; (4) the dunes continue their movement independently of the lakes; (5) the lakes are relatively recent creations, and are supplied with water from the Tarim; (6) once the metamorphosis is successfully accomplished, the existing lakes will become converted into dune-valleys with a level bottom whereon vegetation will grow. Before proceeding to consider certain other problems connected with these lakes, I must first communicate the detail results of various other investigations which I carried out in this same region.



Fig. 215.

Returning to Gölme-käti-köl. To the east of its south-eastern part lies a small dry bajir, with a larger one to the north of it called Emin Achune-uktusu. Although not connected, they form as it were a continuation of one another, and as usual stretch from north-north-east to south-south-west, that is to say parallel to the



Fig. 100.

*Instr. A B Lagrelius & Westphal.*

THE DESERT-LAKE OF TUS-ALGHUTSCH AS SEEN FROM THE DUNES OF THE RIGHT BANK OF THE TARIM.

In the foreground is the Channel which provides the Lake with Water from the River.





lakes and the crests of the dunes. The name, Emin Achun's lake, proves that this depression, now dry, once contained water, and that the connecting channel was made by a man of that name. If this channel, which is considerably longer than the feeding canal of Gölme-käti, were to be opened when the Tarim is in full flood, in all probability the depression would again be filled with water. The only difference therefore between Gölme-käti and Emin Achune-uktusu is this, that the last-named happens at the present time to lie dry, a fate which will also overtake Gölme-käti, if it remains long enough cut off from the river. We have found that Basch-köl is in the same position: this lake at one period dried up, and even at the time of my visit, in consequence of its disconnection from the river, its water was impregnated with salt. These lake-basins therefore have no connection with the natural ground-water, but are simply so many accumulations of water occupying so many natural depressions. For instance, upon digging a well on the shore of Basch-köl at a distance not exceeding ten or twenty meters from the edge of the lake, the water which appeared in the well rose to the level of its surface, percolating through directly from the lake. In the case of the Basch-köl there could be no doubt about it, for the water in both well and lake was alike salt. Hence loss by evaporation is not the only consequence of stopping the inflow of water into these lakes; they lose in volume also through absorption into the ground. Each lake and bajir coincides with a depression. From this it does not however at all follow that the substratum or underlying clay soil, upon which the dunes are built up, is furrowed or channelled naturally into oblong, oval, or elliptical depressions, which would be distinctly perceptible supposing all the superimposed sand to be removed. Were this the configuration of the underlying surface, one would expect to find similar furrows on the left or east bank of the Tarim, at any rate in those districts which have never been inundated by the river, but of such there are none.\* For this, as well as for other reasons, I assume that the surface on the right bank of the Tarim was originally to all intents and purposes level, allowing of course for the extremely gentle slope towards the lowest depression of the Tarim basin in the south-east. The underlying clay foundation is relatively soft, and admits to a certain degree of being compressed, especially where, as at no great depth throughout the whole of the Desert of Tschertschen, it is moist. In the arid Desert of Lop the clay is so hard that horses' hoofs leave scarce any impression upon it. On the other hand in those parts of the Desert of Tschertschen where the sand has been removed, the exposed clay is soft. I am therefore tempted to put forward the somewhat bold hypothesis, that the dune-accumulations, in consequence of their weight, produce an indentation of the ground by compressing the underlying layer of loose moist arenaceous clay. These indentations are not however permanent, but move as the dune moves; and as the soil on the leeward side of the on-moving dune is compressed, so the soil on its windward side recovers its elasticity and uplifts itself again as soon as the pressure of the superincumbent dune is taken off it. Thus the indentations never become exposed to observation, so that to establish the actual fact of their existence is well-nigh an impossibility. If my assumption is right, it

\* The trenches which extend from the north-east to the south-west in the bed of the ancient Lop-nor are of a totally different kind.

follows of absolute necessity that those portions of the underlying substratum which are exempt from the presence of dunes, and consequently are subjected to no pressure, will assume the shape of long, low ridges or elevations running between the masses of the dunes, that is between every pair of parallel dune-accumulations, and this all the more when we call to mind that the displaced material naturally gravitates towards those positions which are free from pressure, in the way shown by the arrows in the accompanying fig. (216). The total amount of the compression is naturally extremely small; but insignificant though it be, there is always a difference of elevation between the areas subjected to the pressure of the dunes and the areas which are exempt from it. The contour of the substratum presents in section an undulatory outline, similar to, though not especially coincident with, that of the overlying dunes, although it owes its origin to a different cause, and is very much less accentuated. The two series of undulations run parallel to one another at precisely the same rate of speed, or rather the same rate of slowness. But the crests of the dunes lie immediately above the hollows of the substratum, and the dune-valleys rest upon the tops of the ridges of the substratum. All this is however theoretical; in actual fact, the circumstances are quite otherwise. For at the bottom of the dune-valleys, where, according to the reasonings adduced above, the ridges of the substratum ought to be, we find depressions, the presence of which is most clearly indicated by the fact that they contain lakes which go down as low as 11 meters in depth.

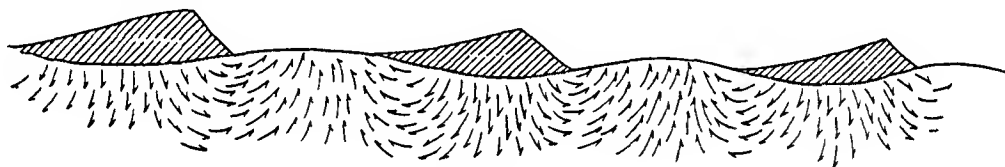


Fig. 216.

Is this fact then in conflict with my theory? By no means. The Tarim, in consequence of its movement towards the right, has naturally in many respects altered the character of the country. To begin with, it has cut away the north-eastern parts of the desert to such an extent that the edge of the latter now stands up sharp and steep like a mountain-escarpment along its right bank. Before the advent of the river, the dunes here had a gentle slope towards the north-east and east, and decreased in elevation in proportion as they approached the western shore of the former Lop-nor. But in other respects, that is apart from the transportation of these enormous masses of sand, and apart from the arrival of surface water from the river, the desert possessed precisely the same attributes and characteristics as at the present time. The ground-water stood at the same level as it does now; at least I have reason to infer so from the wells which I dug in the middle of the Desert of Tschertschen (see Chapters XX and XXI). These led me to believe that the state of the ground-water is independent of the relatively insignificant migrations of the Tarim and the Lop-nor. If the ground-water were to any appreciable extent dependent upon these movements, its level would naturally fall in proportion as the water-supply which the Tarim brings to the Lop-nor region diminishes, as it does diminish, in quantity, and is still going on diminishing.

I assume therefore, that, previous to the Tarim's occupying its present situation, the dune-valleys which now contain lakes were already in existence, but in the shape of ordinary bajirs. I assume further, that the soil, where not covered by sand (see fig. 216), formed, theoretically, elevations as compared with those tracts which were overlain by dunes. That is to say, they would have formed elevations, had it not been for the counteracting influence of another factor which prevented them from doing so, namely a force which gradually came into play as the super-incumbent dunes advanced, and as a consequence of that advance, and which scooped them out as the on-moving dunes left them exposed. That force is the wind. The energy it puts forth can hardly be called deflation in the proper and usual acceptance of the term, but it is at any rate an expression of the wind's property of carrying away the finely pulverised, superficial, and perfectly dry dust, which, as we shall see subsequently, constitutes the bottom covering of the bajirs. To some extent corrasion is also operative, though as an effect not of the prevailing east wind, but rather of the south-west and north-east winds, which seem to blow sometimes during the winter. After this finely comminuted material has been lifted into the air by the last-named winds, it hangs suspended there until such time as the first dominating currents of the atmosphere from the east seize upon it, and sweep it westwards, creating in the interior of the great desert of East Turkestan, as I observed myself in February 1896,\* a state of complete twilight even when there is an entire absence of wind.\*\* A conclusive proof that this haze, which completely neutralizes the effect of the sun, is nothing but fine dust is to be found in the *topa-jamgor*, or »dust-rain», which deposits upon every object exposed to it a thin coating of fine, light yellow dust. If it be true, as it is true, that not all the fine dust which I saw beside the Kerija-darja originated from the bajirs, still it cannot be denied, that an integral portion of it must be traced to that source. In the Lop country the dust-haze is hardly so thick as beside the Kerija-darja. Consequently the latter can scarcely originate in any other region except the Tschertschen Desert, the greater part of it indeed from the bajirs of that desert, the floor of which consists of just such fine loose, imponderable material as we find in the deposits of the dust-rain. And we have a further confirmation of this in the circumstance that the dust-haze of the Kerija-darja appears every year in February, sometimes it may be a little earlier, sometimes a little later, it all depends upon when the first burans set in from the east. But the phenomenon which we are here considering owes its origin to a combination of circumstances, from amongst which it is not always easy to select those which have been chiefly instrumental in bringing it about. For instance, when we find that the surface of each bajir in the Tschertschen Desert is covered with a layer of fine dust, at least some decimeters thick, and that the gentlest puff of wind is sufficient to waft it away in clouds, it is equally open to us to say, that these sheltered depressions are just the places which the atmospheric dust chooses to settle in. And undoubtedly this does take place; but then it no more precludes the occurrence I have spoken of than the deposition of sediment by a river is prohibitive of its exercising erosive power. The only wind

\* In the year 1899 the first storm in the Lop country made its appearance on 25th February.

\*\* See *Petermanns Mitteilungen*, *Ergänzungsheft* 131, p. 53.

which governs or determines the movements of the dune-masses is the east wind; so far as I was able to see, these masses are practically unmoved by winds from other quarters. But this is not true when applied to the loose dust deposited in the bajirs. By their very positions the bajirs are especially exposed to the winds from the north-east and south-west, and as a consequence of this their floors are subjected to a wind erosion that leaves the dunes otherwise untouched. Whereas a wind from either of these directions excavates the bottom of the bajir, a gentler wind, or even the calm which succeeds a tempest, may cause the dust which is floating in the air to settle on the floor of the same bajir. The resultant effect of these two agencies is that, as time goes on, the basin of the bajir becomes hollowed out deeper and deeper, just as in a similar way the ultimate result of the river's activity is to give it an excavated, but changeable, bed.

To gather to a head the threads of my argument, let me say here that, while, theoretically, the effect of the pressure of the dunes is to make the dune-valleys convex, that effect is *de facto* more than neutralized by the action of the wind, which makes them concave.

Nor is it difficult to give an actual proof of this wind erosion; the shape of the bajirs alone is enough to prove it. Each bajir is always deepest on its eastern side, that is to say on that side which lies at the leeward base of the advancing dune. This may in part be because that side of the bajir is the one most exposed to the dune-pressure, whereas the more gently rising dune on the opposite or western side, being for that reason smaller in mass, exercises a less amount of pressure. But the determining factor, the real power which effectually imparts to the bajirs the shape they



Fig. 217.

exhibit, is the wind. The annexed fig. (218) illustrates the way in which it acts. Let us suppose that the sectional line  $a-a'-b'-c'-d'-e'-a''-a'''$  represents the leeward side of a dune, the windward side of the next dune, and the intervening clay floor of a bajir. After a certain period the superficial layer of the bajir will be carried away by the wind. During this period the dune-wall  $a-a'$  advances, and those portions of the eastern side of the bajir which become buried under the advancing sand-slides become so far forth protected against wind-erosion, as well as pass beyond the reach of our

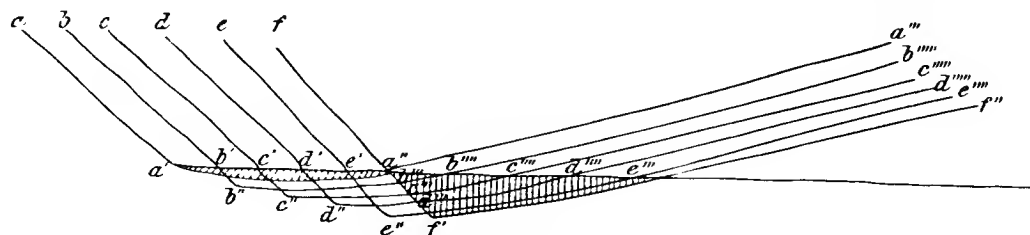


Fig. 218.

observation. After this the cross-section of the dune valley assumes the outline  $b\ b'\ b''\ b'''\ b''''\ b'''''$ , whilst during this same period the portion  $a''\ b''''$ , which was at first covered by the lower windward slopes of the migratory dune on the west side of the bajir, now becomes exposed, its sand is swept away, and it becomes itself subject to the erosive action of the wind. A fresh phase in the process is exhibited in  $c\ c'\ c''\ c'''\ c''''\ c'''''$ . The depth of the bajir at  $c''$  becomes greater than it was at  $b''$ , because the former has been longer exposed to the effects of the wind's erosion. Meanwhile a fresh portion of the underlying stratum  $b''''\ c''''$ , which was originally covered, now comes to light, and the layer  $a''\ b'''\ b''''$  has been swept away off the immediately preceding belt to the east,  $a''\ b''''$ . When finally the section assumes the form  $e\ e'\ e''\ e'''\ e''''$ , the point  $e''$  coincides with the point  $a''$ , that is the westernmost point of the floor of the bajir taking it as it was when we began this series of supposed movements. All through the successive periods  $ab$ ,  $bc$ ,  $cd$ , and  $de$  this point has been uninterruptedly exposed to the erosive action of the wind, whereas the points  $e'\ d'\ c'$  and  $b'$  having been exposed for shorter periods respectively, have only been eroded to the successive depths of  $d''$ ,  $c''$ , and  $b''$ . Thus  $a''\ e''$  is the measure of the maximum depth to which the wind is able to excavate this bajir, for the next stage in the movement  $f\ f'\ f''$  makes the depth of  $f'$  precisely the same as the depth of  $e''$ ; and similar coincidences are produced with each fresh step that the dune takes westwards. Hence the maximum depth in each individual bajir remains, *ceteris paribus*, constantly and unchangeably the same, namely equivalent to  $a''\ e''$ , so that this gives the maximum value of the power of the wind's erosive energy at the point (point in the section, but a line in reality) which is longest exposed to its influence. And this is no mere theoretical construction, but is a true representation of what actually occurs; for every bajir, no matter in what part of the desert it may be situated, presents in cross-section the curve which I have shown and described, that is to say, its concavity dips lowest on the east and gradually curves up towards the west. How is it possible to explain in any other way the extreme regularity in the moulding of the surface of the substratum? If the ground upon which the dunes rests were in itself undulating or furrowed, some of the bajirs would be deepest in the west, while others of the dune-valleys would be replaced by swellings or elevations of the surface. But to the law which I have stated there does not exist so much as a single exception. Indeed we may with good reason say that in the interior of the Desert of Tschertschen there is but one power of nature which is actively at work, and that is the wind. In other regions other powers are also operative in modelling the relief features, such as denudation (which by its disintegrating action opens the door to the rupturing influences of the frost), changes of temperature, precipitation, erosion, deposition of alluvium, corrasion, deflation, and the direct and indirect effects of the presence of organic life. But the materials of which the Tschertschen Desert is composed consist entirely of the products of disintegration and alluvial formation, these and nothing else, and they are, as it were, immune from every other influence except the power of the wind to transport those of their particles which are sufficiently light and imponderable. The violent storms remove bodily *all* material that is unsheltered, while the gentle winds act through deflation. Thus not only the existence of the bajirs

themselves, but also the uniform regularity of their forms, are due to the wind; and the latter circumstance, the law governing the shape of the bajirs, is a further proof that the dune-masses are actually travelling westwards. If in fig. 219 we suppose that the completed horizontal line indicates the original level of the clay substratum, and the dotted line drawn parallel to it indicates the depth of the bajir at successive stages of its westward advance, then we find that the size and shape of the bajir remain constant, presuming that the relations of the wind and of the underlying substratum also remain constant; in other words, the triangle  $a a' a''$  remains invariably equal to the triangle  $f f' f''$ , and we also find that each bajir accompanies its containing or bordering dunes with the same fidelity as any other dune valley. Though the materials change, the hollow always remains.

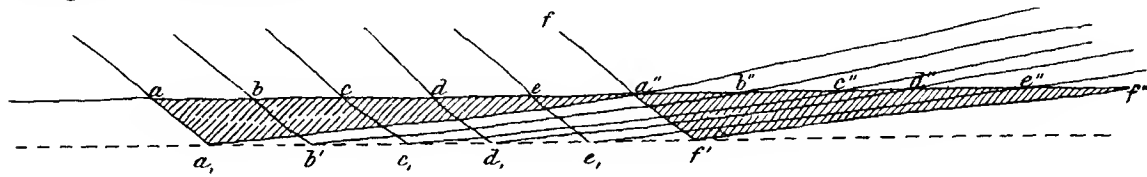


Fig. 219.

Now the Gölme-käti is nothing but a bajir which happens to be full of water. Under these circumstances the bajir has but to encounter a hindrance in its path (as I have already set forth — see fig. 213) for its western edge to become fixed, whilst its eastern side continues its advance until the lake-basin is filled and levelled up with sand. In this case the impediments to the wind's activity are partly the water, partly the vegetation. In case however no vegetation succeeds in getting root on the west side of the lake, then and then only, and in proportion as the dune moves, does that shore become exposed to the effects of the wind, and each section  $ab$ ,  $ac$ ,  $ad$  (fig. 220) is successively eroded. This obviously carries with it

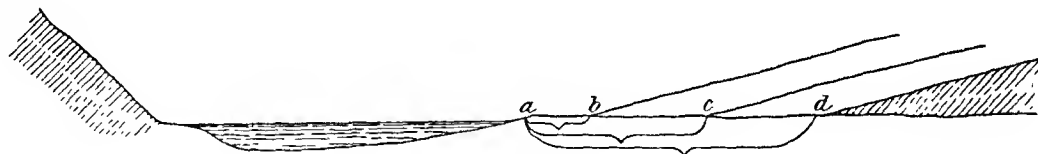


Fig. 220.

as an implication, that the lake also advances as the shore recedes, and as it advances keeps filling with water each freshly formed hollow. In actual fact this never happens, just because there always is the impeding vegetation. After a time the cross-section  $a a' a'' a'''$  (fig. 221), which embraces a lake, becomes converted into the cross-section  $c e' b'' c'' d'' e'' e'''$ , embracing a level bajir with ve-

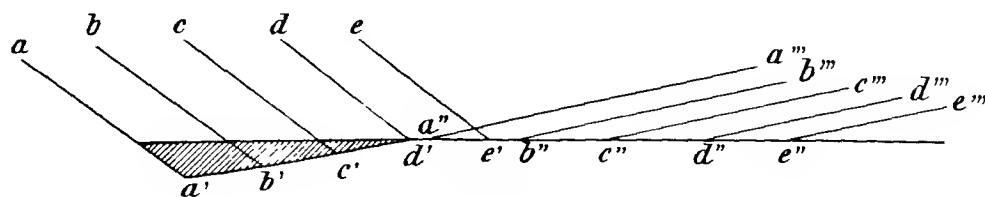


Fig. 221.

getation. In case the Tarim should quit its existing bed, and recede towards the east, and the vegetation should wither and die, the new bajir would become the prey of the excavating action of the wind. And if then the river were once again to return to its present position, the former (now existing) lake would be reformed, but in a different shape and in a different place. As things are now, the procedure would appear to be that illustrated in fig. 222. A is the dune-mass between Emin Achune-uktusu and Gölme-käti, after it has travelled across the former lake. Assuming that the Emin Achune-uktusu remains dry, it too will share in the migration, and will continue to travel across the former lake-basin of the Gölme-käti, while its place will be taken by a new bajir, level and bearing vegetation, between the dunes A and B.

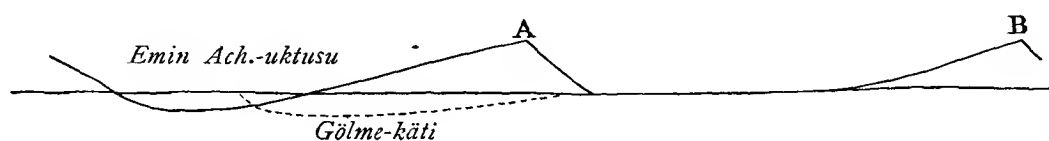


Fig. 222.

On the prolongation of the south-south-west axis of the Gölme-käti there is, as in the case of the Jangi-köl, a little bajir, separated from the lake by a tongue of land and itself containing salt water. As I have already stated, my trip on the Gölme-käti proved unsuccessful in so far as soundings were concerned. The lake was so rough that both our canoes filled and sank, though fortunately in shallow water. Thus we had ocular demonstration of the great effect which the impact of the waves has in shaping the outline of the lake. In the shallower lakes, where the beat of the waves is quite as strong as in the Gölme-käti, their effect must reach quite to the bottom, levelling it and moulding it. Nevertheless the bathymetrical relations always furnish a key to the shape of the original depression and the lie of the dune-waves. Except in the north, where it is mud or ooze, the bottom of the Gölme-käti consists of sand. This lake is considered to furnish excellent fishing. Algæ are found along the northern and eastern shores. The following names occur in connection with this lake — Beschik-kaldi, the district east of its canal; Tokta Niase-modschughu, the name of a spot where three or four poplars grow on the east bank; a similar spot, close beside it, is called Chodscheli-modschughu; Chodscheli-boltoso, or quite simply Bolto (the Sound), is the name applied to the narrowest part of the lake, where a projecting strip of dune divides it into two basins; a deep bay south of this promontory bears the name of Jolsis-kakmar; farther south there is a very blunted promontory known as Abdu Semeti-modschughu. In the extreme south we noted two wide-open bays parted by a truncated dune. On the west shore I recorded one name, Toghrak-modschuk, a poplar grove.



## CHAPTER XVII.

THE TOGHRAKLIK-KÖL AND THE KARAUNELIK-KÖL.  
MUTUAL RELATIONS OF LAKES AND DUNES.

Immediately south-east of Emin Achune-uktusu lies, on the right bank of the Tarim, the lake of Toghraklik-köl, or the Poplar Lake, with its canal. It is a small and insignificant sheet of water, divided into two basins. Of these the south-eastern one alone is surrounded by dunes; the northern basin has dunes on its southern shore only, its north-western shore being a reedy marsh. The form and situation of the lake suggest that it is shallow and, relatively speaking, must soon disappear. South-east of this lake there is an unusually broad and massive accumulation of sand, stretching right away to the western shore of the Karaunelik-köl, or Black Goose Lake.

On 20th May 1900 I made a little excursion to the last-named, and thereby in some respects enlarged my experience of this strange land, where water, sand, and wind are engaged in a desperate and mutually hostile warfare. Our ferry-boat was at that time anchored to the left bank of the Tarim, directly opposite to the entrance of the canal, 600 meters long, that feeds the lake. The Karaunelik-köl is elongated, and stretches from north-north-east to south-south-west, its greatest length being 5.2 km. Of this distance 2 km. measure the length of the northern basin, the width of which is 0.95 km., while the southern basin is 3.2 km. long and 2.0 km. broad. The sound (*bolto*) which connects these two basins in the middle is 300 m. across. Although this lake is thus totally unlike the Gölme-käti in respect of shape, there are nevertheless several points or features in which they resemble one another. Gölme-käti does indeed show a tendency to become likewise divided into two by a couple of sandy headlands which jut out to meet one another; still the sound which parts them is much broader than that in the Karaunelik-köl. The contours here are of course determined by the shape and disposition of the adjacent dunes, and as the different dune elevations are built up and impelled forward by the same wind, it is not surprising to find that a certain degree of parallelism prevails amongst the lakes also, and extends to the contours of their shores. In the case of both these lakes the median contraction is caused by a projecting segment of the dunes. The sand which forms the slope of the eastern shore of the sound appears to have

descended from the culminating summit of the dune, the immense height of which (90 m.) has caused the sand to pour down in greater volume, and consequently to encroach farther upon the lake at that particular spot. It is an equally natural and inevitable consequence of this more active and more voluminous downpour of sand, that a similar promontory is formed on the opposite shore, though one pointing in the opposite direction, that is towards the east. Without pausing to discuss the question, whether a high ponderous dune-mass travels faster or slower than a lighter mass of lower elevation, I will merely state it as a fact, that one and the same identical chain of dunes, which may stretch for many scores, or even hundreds, of kilometers through the desert, does not run in a straight line, but forms an undulating, or rather a sort of »festooned», line. The bulging parts of the line, or the curves which are in advance, that is to say the portions which travel at the fastest rate, are likewise those which are highest. It is so, at all events, on the east side of the Karaunelik-köl. The dune ascends to an altitude of 90 m., and the sound to which the lake contracts at its foot is only 300 m. broad. If now we imagine the depression to be dry like an ordinary bajir, then that portion of the dune-slope on the west side of the lake which lies immediately opposite to the east-shore projection will be sheltered, at any rate in part, against the wind, and consequently will not advance westwards at the same speed as the other parts of the same dune-chain. It lags, as it were, behind the rest, and fails to keep its dressing. And the farther the eastern promontory advances, the greater becomes the shelter it affords against the wind, and consequently the greater grows also the retardation of the opposite promontory. In the end the advancing eastern promontory overtakes its lagging *vis-à-vis* and overwhelms it with its on-pouring masses of sand. In this way the two basins of the bajir become entirely separated the one from the other by a transverse neck or ridge of sand, which continues to increase in height as time goes on, and is almost always bordered on the east by a steep wall of advancing sand. This is the stage which has been reached by the neck of sand that divides the southern basin of the Karaunelik-köl from the bajir which lies south-south-west of it. And as I shall show subsequently, similar conditions prevail throughout the interior of the Desert of Tschertschen.

Nevertheless there do exist exceptions to this rule. We have already seen that in both the Basch-köl and the Jangi-köl the shore-lines are parallel, and that these two elongated depressions possess neither narrow sounds nor projecting promontories in the middle. Indeed in the case of the second of these two lakes these characteristics are so pronounced that its basin resembles a gently winding river-bed, each concave and convex curve on the one side being matched by an exactly similar convex or concave curve on the opposite side. This may be due to the entire stretch of dunes on the east shore being of one uniform height, so that the whole line of dunes marches forward at an equal pace, or what amounts to the same thing, there exists no reason why any one part of the line should advance faster than the rest. But at the southern end of each of these lakes there is a neck of sand separating it from the bajir which forms the continuation of its longer axis. This neck of sand has however arisen in the way I have just described; and the various successive stages of its growth are depicted in the accompanying fig. (223).

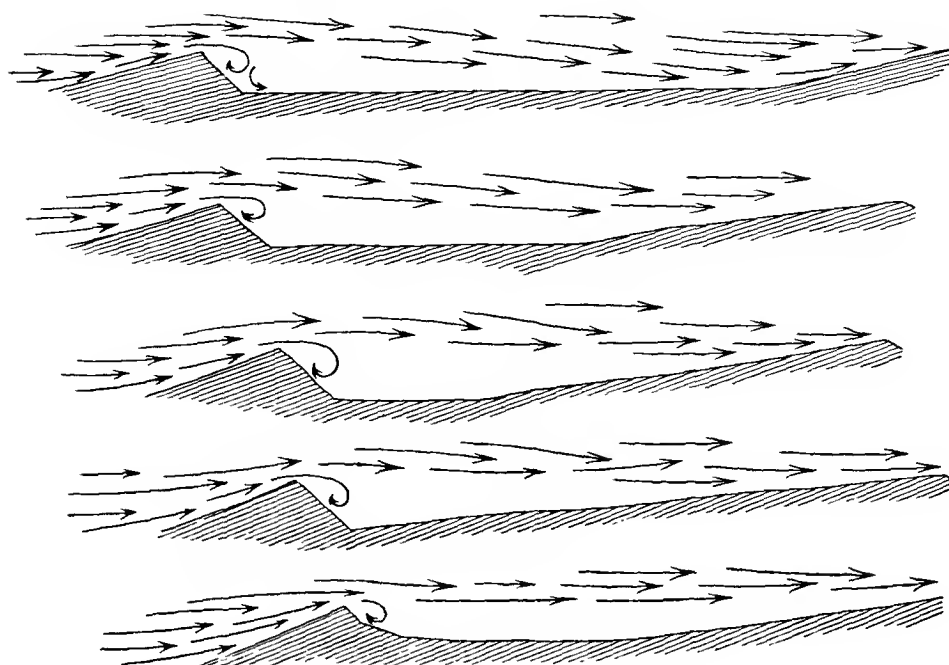


Fig. 223.



Fig. 224.

From what has been already said, it will readily be seen that the procedure will be to some extent affected when the depression is filled with water. In that case the western shore remains practically unaltered. We may not assume, that the meeting of the two approaching promontories, under circumstances similar to the *bolto* of the Karaunelik-köl, is in any way accelerated by drift-sand being blown from the summit of the dune down into the sound, thus filling it up. If that were indeed the case, the sound would be a good deal shallower than it actually is. Its depth runs to 7.75 m. and 6.13 m., whereas the very deepest sounding we obtained anywhere in this lake was 9.40 m. In other words, the sound is traversed by a deep trough or trench, and this lies immediately underneath the steep leeward wall of the sand-dunes. True drift-sand is not in fact carried to any great distance by the wind, but is brushed up and driven along the face of the dune, over its top, and then falls down on the other side. It is true that, whilst the tempest was careering across the Gölme-käti, we did indeed observe the sand hanging over from the sharp edges of the dunes in the shape of plumes and comets' tails; but they were in each case of brief duration, being speedily broken up by the wind, which



Fig. 225.

sifted the light dust from the heavy sand, dropping the latter down the leeward face of the dune, but wafting the lighter material away, and thus in conformity with the laws of

gravitation, performed its work more surely than any goldminer's »rocker» separates the precious grains from the »dirt» with which it is associated. And even though the sound did not get sanded up in this way, it must inevitably be clipped in two as soon as the eastern promontory meets and coalesces with the western.

The Sejt-köl, which, as I have already said, I only saw from the top of a high dune, is a lake of the same type as the Karaunelik-köl. It too contracts in the middle, and thus consists of two elliptical lake basins, as may be seen from the photograph on Pl. 39. The only difference between the two lakes appears to be this, that in the case of the Sejt-köl, it is the southern basin which is the smaller.

Nor is it indeed surprising to find that geographical homologies do exist in the case of lakes which originate under precisely similar conditions such as these do. The little promontory situated south-east of the point where the feeding-canal enters the Karaunelik-köl bears the name of Tokta Niasne-modschughu, the very same name which is borne by the corresponding, but rudimentary, cape south-east of the mouth of the feeding-canal of the Gölme-käti. In both cases the narrow connecting-sound between the two basins is called Bolto, and the bay on the east shore, south of the sound, is known as Kakmar, a word which signifies »deep bay (suitable for fishing)». The *kakmar* of the Karaunelik-köl is called Kaghune-kakmasi; a promontory to the north of it is Arsu Kullu Schek-modschughu, the promontory east of the sound Mahmetne-modschughu; and the shore to the north of it Bobane-ottogho. The sound itself is known as Kungul-koschu-boltasi, Kungul being a man's name, while *koschu-boltasi* signifies »double sound»; and the name is quite justified by the fact that the eastern promontory has two projecting points, so that, correctly speaking, we ought to talk of two narrow passages. To the south-east of this lake there is another promontory called Chodscheli-modschughu, a name which we have already met with in the Gölme-käti. On the south-western shore is the rounded promontory of Muptu Achune-modschughu, while the tract beside the canal is called Ilias Murab-salghan, meaning »Made by Ilias Murab», presumably the man who first undertook to regulate the canal. Thus all these names perpetuate the names of people who had something to do with each place in question — dug the canal, dwelt on a promontory, fished in a kakmar, and so forth. Even Bobane-ottogho, »the Old Man's Dwelling-place», preserves the recollection of some aged man who established himself with his household Penates at the foot of the sand-dune. At Basch-köl and Jangi-köl I was not given any similar local nomenclature, probably because the shores of those lakes are too regular to have acquired distinctive names.

One noteworthy fact in connection with the Karaunelik-köl is, that practically all the poplars stand on its eastern shore, where they are in danger of being buried under the sand. But when they root themselves, they have of course no conception of the peril that threatens them or of the fate that will overtake them. On the west shore I did not notice more than two or three of these trees. Of those on the opposite side there were several already covered with sand, while others, growing on less steep slopes, appeared to be avoided by it. If this last circumstance is anything more than a pure coincidence, it points to the fact that these poplars occupy a position which is better sheltered against the easterly gales. This may explain not only their greater numbers on that side, but also their vigorous appearance. On the other hand the broader strip of shore on

the west side of the lake encourages the growth of reeds, which, owing to their thicker, closer growth, are less susceptible to the wind than poplars standing solitary and alone. Sedge (*jäkän*) occurs in the water near the west side of the sound, as well as immediately around the mouth of the canal. But we did not see any Algæ, the lake-bottom being covered throughout with sand. The fauna was confined to hares, wagtails, and terns, though these were all seen singly. Beside the canal one of my Cossacks shot a wild-boar. There were very numerous signs of these last, in their rootings amongst the reeds.

The number of soundings which I was able to take in this lake was not sufficient to afford a perfectly correct plan of the shape of its floor. But they do at all events suggest an approximate idea of the general relief, and this must be accepted as sufficient in the case of lakes that are so small and have such a precarious existence as these; for they could be emptied and filled again by a couple of men who knew how to open and close the feeding-canal. On the map Pl. 41 the isobathic curves have been laid down from the soundings I took, supplemented by interpolation, in which probability and analogy rendered great assistance. As in the Gölme-käti, the greatest depth was found in the southern part of the lake, quite close to the eastern shore; and this is indeed what we should expect, if the theory I have propounded as to the origin of the lake, and illustrated in fig. 218, is correct. At the same time the presence of the water makes a difference. The sand which pours down the leeward flank of the dune becomes in the lake considerably lighter than when in the air, and it is carried out towards the middle by the action of the waves, and these in such a shallow basin probably propagate their effects all the way to the bottom. If in the dry depression the foot of the dune is at *a* fig. (226), then when the basin becomes filled with water the dune-foot advances successively to *b*, *c*, and *d*. There is however a limit to the distance to which the foot of this submarine sand-slope can advance, and it is such as to prevent the wave-action, no matter how energetically it may level the lake-bottom by distributing the sand over it, from ever transferring the maximum depth to the topographical centre of the lake. For if we suppose the sand-slope or scree to make a step forward to *e*, then at the same time the dune itself also advances, and in like manner the maximum depth always lies immediately adjacent to the east shore, even where the lake contracts as much as it does at *f*.

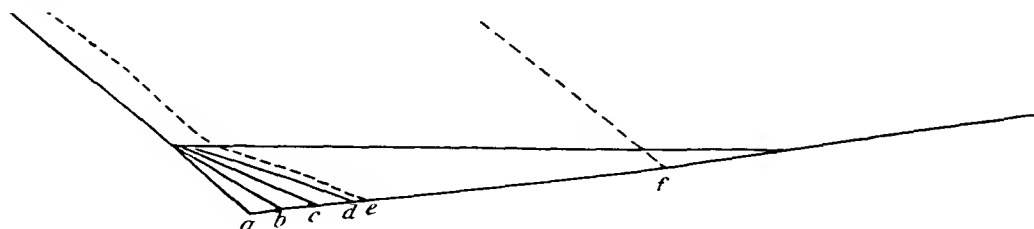


Fig. 226.

The difference between the two opposite shores is seen from the following example. From Muptu Achune-modschughu the contour, going west, rises 1.47 m. in the first 43 m., or in other words the ground slopes down towards the shore-line 1 in 29.4 m. East of the same place the depth at a distance of 90 m. is 5.98 m., giving

a slope of 1 in 15 m. Thus the curve of the contour forms here a convex angle; whereas the corresponding angle on the eastern shore is concave, as indeed will readily be seen when it is remembered, that the dunes descend at an angle of  $33^{\circ}$ , while the lake-bottom has a slope of only two or three degrees. The difference between the opposite shores in this respect is in part due to the wave-action, which is especially vigorous on the west shore, washing the loose materials out towards the middle of the lake, while the strip of shore is held together by the vegetation and has but a gentle slope upwards. In a lake so oval and regular in outline as the southern basin of the Karaunelik-köl there is every likelihood that the wave-action will in the course of time obliterate all the irregularities in its bed, or at any rate make the transitions as easy and as gradual as is exhibited in the fig.



Fig. 227.

The lake's northern and smaller basin is an even more beautiful and convincing illustration of the typically shaped bajir as I have theoretically conceived it. Here at only about a score of meters from the eastern shore we obtained a depth of 6.75 m., and on that side the isobathic lines are crowded together, whereas approaching the western shore they fall much wider apart. In the southern basin the maximum depth is 9.40 m., in the northern it is only 7.82 m., and here again it occurs nearest to the south-east corner. Nor is it at all surprising to find that the greater depth occurs in the southern basin, for the greater the area of a bajir depression the more it is exposed, and that for a longer time, to the erosive action of the wind; and as the north-north-east wind is probably more frequent than the south-south-west wind, it is the southern part of the bajir which suffers most from wind excavation. From the fact of all the topographical names being confined to the eastern shore, it would appear that the fishing is best on that side, a consequence probably of the greater depth and greater tranquillity of the water.

The water of the Karaunelik-köl was of different shades of colour owing to the canal being open, so that a lively current was flowing in from the river. The grey muddy fluvial water spread itself out fan-like for some distance from the mouth of the canal; but at the distance of a couple of hundred meters it became merged in the pure emerald green water of the lake itself. The water in the southern basin was clearer still, and as pure as that of the purest wellspring. Although this, when seen against the sand or the sky, appeared green, nevertheless, when contrasted with the fresh and vivid green of the poplars, it appeared to be rather a blue. Anyway these crisp freshwater lakes, silent and lifeless though they are, strike one as both fascinating and sublime when one comes upon them slumbering amid the stifling heat of the desert. A most curious, a characteristic and paradoxical phenomenon — to stumble across lakes like these in a region which is the very last of all in which one would expect to find anything in the nature of a lake! Although they suggest several more or less intricate morphological and hydro-

graphical problems, they also at the same time contribute in an essential degree towards the solution of important questions of physical geography.

The canal which feeds the Karaunelik-köl is narrowest at the point where it branches off from the right bank of the Tarim, though even there its breadth amounts to 17.30 m. Thence it gradually widens as it advances, until at its entrance into the lake its width is quite double the figure just quoted. The mean depth was 0.60 m.; the mean velocity of the current, 0.223 m.; and the volume, 2.3 cub.m. in the second. At this point the maximum depth of the canal was 0.77 m. When the river drops this much, as it does by the autumn, the inflow into the lake ceases, but not before, because the canal as it approaches the lake grows at the same time both wider and deeper. For this reason the only spot at which we were able to measure its current with sufficient certainty was over the threshold, where the breadth amounted to 17.30 m.

The volume of 2.3 cub.m., the measure of the contribution which the Karaunelik-köl levies upon the Tarim every second, suggests interesting conclusions as to the mutual relations between the river and the lake. Seeing that the volume of the river at this time was 72 cub.m., then the Karaunelik-köl drained away  $\frac{1}{31}$ th of the river's total flood, and to that extent deprived the Kara-koschun of an equivalent amount. In other words, so long as the Karaunelik-köl is kept open, it robs the terminal basin of the Tarim of a large volume of its water. But to this problem, which throws so much light upon the question of the steady shrinkage and desiccation of the Kara-koschun, we shall return again lower down.

Let us now for a moment consider the situation in which we found these two, the Tarim and the Karaunelik-köl, on 20th May. The question arises, why does the water flow from the river into the lake? Obviously because the level of the lake is lower than the level of the river. The difference of level was however as little as it well could be, for at a distance of only 600 meters the mean velocity, where the current ran strongest, was only 0.223 m. in the second. The reason a difference of level exists at all is no doubt this, that the lake loses water partly through absorption into the containing walls of the basin, partly also, and in all probability chiefly, through evaporation. In consequence of this the level of the lake is constantly sinking, and the loss thus occasioned is, just as constantly, being made good from the river. In a word, the current that flows from the river is caused by the »aspiration» or suction of the lake.

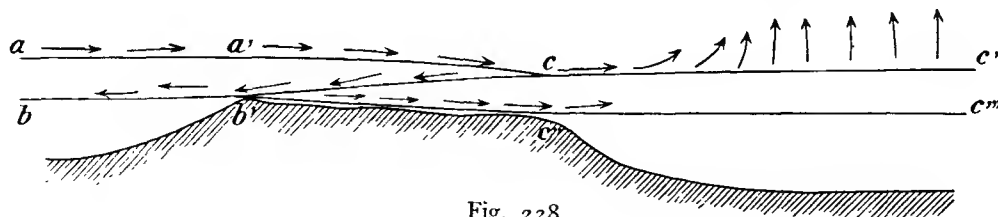


Fig. 228.

The action is illustrated by fig. 228. The dotted part of the figure represents the river-bed, the bed of the canal, and the bottom of the lake. The level of the river is shown by  $a-a'$ , the slope or inclination of the canal by  $a'-c$ , and the level of the lake by  $c-c'$ ; while the arrows indicate the flow of the water, partly in the canal, partly as it ascends in evaporation. It is of course self-evident, that many variations of these

relations will occur in consequence of the alterations in the level of the river. So long as the spring freshets are running in full flood, a considerably greater volume flows into the lake than at the time of our visit. If the river drops subsequently at a sufficiently rapid rate to the level  $b-b'$ , a portion of the water will flow back out of the lake, in order to restore the equilibrium. But when the river drops slowly and gradually, the lake subsides at the same rate,  $b\ b'\ c''\ c'''$ , while the current in the canal grows slow, or else entirely ceases.

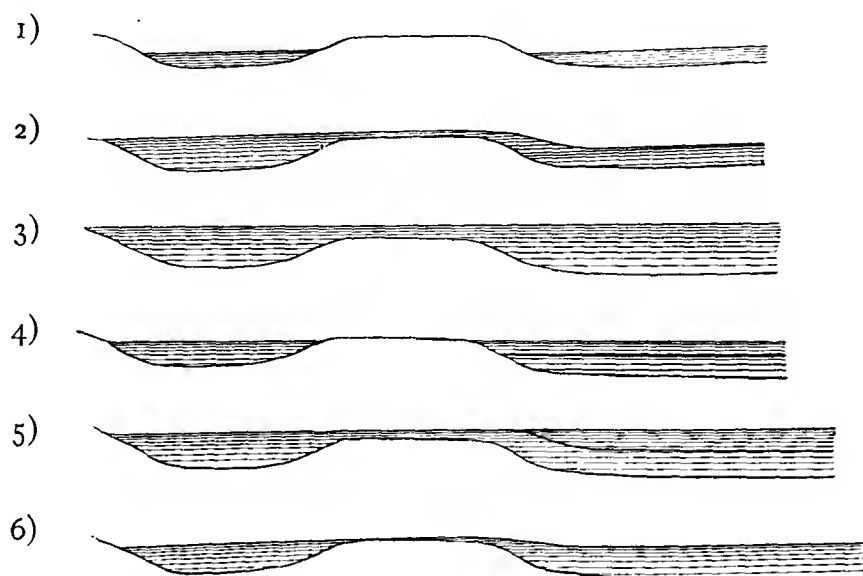


Fig. 229.

The subjoined diagram (229) will illustrate the different phases in the changes of level. (1) At this stadium the river is at its lowest ebb about the 1st August; the canal is then entirely dry, and the lake completely cut off from the river, and in consequence of this it shrinks daily. (2) In the end of September or the beginning of October comes the high flood, and the Tarim rises to its absolute maximum; the water rushes with torrential violence, probably with several dozen of cubic meters in the second, into the lake. (3) Very soon the lake is filled, and in the beginning of November it stands at the same level as the river, notwithstanding the suction which is set up through evaporation. (4) When the frost comes, both river and lake become icebound, and in the beginning of December the lake is again cut off from the river, if for no other reason, then certainly for this, that the connecting canal is frozen to the bottom. (5) The *mus-suji* or flood from the break-up and melting of the ice in March again causes the river to rise, and the lake-basin to fill again, until we once more reach the position of level which we found on 20th May. But at that date the river was dropping every day. If now the river, after dropping say about half a meter, then remains for some time stationary, whilst the level of the lake gradually falls in consequence of the continuous evaporation — and at this season of the year it is especially active — until it gets below the level of the river; then (6) its aspiratory power is likewise increased, and the current through the canal becomes more lively. This cycle is repeated annually, though subject to infinite variations in conse-



quence of the varying volume of the Tarim. And so powerful is the current in the canal at the two high-water periods that the mud, which accumulates there during quieter seasons, is carried out into the lake, and the canal itself is excavated still deeper.

On the 20th May, then, the Karaunelik-köl received 2.3 cub.m. of water in the second, or 138 cub.m. in the minute, 8,280 cub.m. in the hour, and 198,720 cub.m. in the course of the 24 hours. If now we assume, to begin with, that this flow had been maintained since the 15th March, when the spring freshets first made their appearance at this spot, then during the 66 days which elapsed between the two dates named the lake will have received 13,115,000 cub.m. of water. But in point of actual fact, the inflow has been much greater than this. According to the measurements I made, the volume of the river was

at Schirge-tschapghan	on 19th April	101.86	cub.m.
» Kirtschin	» 7th May	89.06	»
» Jangi-köl	» 16th May	66.03	»
» Kirtschin	» 23rd May	78.58	»
» Arghan	» 4th June	73.08	»
» Schirge-tschapghan	» 10th June	61.38	»

Thus we find that at this season the river drops swiftly, though between the 16th and 23rd May there was an unexpected rise. At Schirge-tschapghan the loss of volume amounted to 40 cub.m. in 52 days, and at Kirtschin to  $11\frac{1}{2}$  cub.m. in 16 days; equivalent in the former case to a fall of 0.77 cub. m., and in the latter to a fall of 0.72 cub. m., in the 24 hours. On 20th May the Tarim had at Karaunelik-köl a volume of about 72.0 cub.m. Had the volume decreased regularly at the same rate from the arrival of the high-flood, that is from about 15th March, the river here would have had a volume of 126 cub.m. in the second. When the river had a volume of 72 cub.m., the Karaunelik-köl drew off 2.3 cub.m. in the second; when the river's volume is 126 cub.m., it is to be assumed *à priori* that the inflow into the lake is very much greater. On the assumption that the changes involved are proportional, the inflow ought then to be 4 cub.m. in the second, or 22,700,000 cub.m. in 66 days. But on 15th March the level of the lake was as shown in (5) in fig. 229, and the water was rushing through the canal like a mill-race. During the winter the surface of the lake had subsided in consequence of the absorption of its water into the ground, and it had been cut off from the river, so that now its suctorial force was inconceivably great. Had the river been then half a meter higher than it was on the 20th May, and had the velocity of the current through the canal been one meter in the second, the canal would have fed the lake to the extent of 19 cub.m. in the second. Except for a vigorous inflow such as this, it would be difficult to explain how, on 20th May, the lake was filled to the level of the river; with an inflow of only 2.3 cub.m. in the second it would be impossible. Thus the estimate 19 cub.m. is if anything too low. If we assume that the mean between this figure and the figure (2.3 cub.m.) obtained by measurement, or say 10 cub.m. in the second, was the value of the inflow during the 66 days, then we obtain a total inflow for that same period of 57,000,000 cub.m., or a solid cube of water each of whose sides measures 385 meters. Let us, to avoid all risk of exaggeration,

take the mean of the three volumes we obtained from our three different methods of measurement — 13, 22, 57 millions — then for the quantity of water which the Karaunelik-köl draws off from the Tarim during the 66 days between 15th March and 20th May we obtain a total of 31 million cub.m.

Turning now for a moment to the cubical capacity of the lake, we find that its area amounts to 5,850,000 square meters, thus distributed — 1,550,000 square meters in the northern, and 4,300,000 square meters in the southern, basin. Soundings were taken at 53 different points, and gave as the mean depth of the lake 5.61 m. Hence the total cubical capacity of the basin is 32,818,500 cub. m., or a solid cube of water each of whose sides measures 319 meters. According to the method of computation adopted above, the lake during the 66 days of high water received an influx of 31 million cub.m. of water. Thus in the space of little more than two months the body of the lake was entirely renewed, and a mass of water equivalent to a cube of 319 meter sides was thus prevented from flowing down to the Kara-koschun. And we may safely assume, that during the autumn flood precisely the same thing takes place (see (2) and (3) fig. 229), the only difference being, that more water is then lost, owing to the evaporation in the lake being incomparably heavier in the summer than in the winter, when the lake is frozen. At this latter season such loss as there is takes place through absorption into the ground. It is easy to conceive what the annual loss of two cubical masses of water such as these signify for the Kara-koschun; and as I have already endeavoured to show that the Tarim is relatively a recent comer in this part, and that the lakes we are discussing are also new creations, it will readily be understood that their origination is one of the causes of the disappearance of the Kara-koschun. Throughout the entire region of the Kara-koschun there does not exist a single open lake possessing the dimensions of the Karaunelik-köl, and what proportion this lake bears to the area of the entire lacustrine system we shall endeavour to calculate lower down. By way of obtaining yet another and final check upon the results we have obtained above, let us assume that the volume of 2.3 cub.m. represents the mean inflow for the whole of the year, and it is rather too low than too high an estimate, then we obtain for the annual drain which the Karaunelik-köl makes upon the river a total of 72,500,000 cub.m., which agrees approximately well with the result we have obtained of two solid cubes each of whose sides measures 319 meters.

When the lake is full and stands at the same level as the river, as it did on the occasion of my visit, then the influx of 2.3 cub.m. in the second is a measure of the amount of water which the lake loses through evaporation and absorption into the ground. Thus it is not enough that all this chain of lakes should be filled, for even when this has been effected, and they have thus levied one heavy contribution upon the river, they go on — that is if the canals are open, as that of the Karaunelik-köl was — to drain away yet other vast volumes of water, and to that extent seriously impair its riverine vitality. We may liken them to polyps or parasites, who have fastened themselves upon the Tarim, and suck away its life-blood, the natural consequence of which is that the river, so to speak, pines away, and its terminal basin, into which all its surplus waters ought properly to be gathered, shrinks year by year.

What proportion of this 2.3 cub.m. inflow is lost by absorption and what proportion by evaporation I cannot now determine; for our present purpose it is sufficient to know, that both these sources of loss do exist. During the winter, when the evaporation is at its minimum, the water under the ice diminishes in volume, but after the ice breaks up and evaporation comes more actively into play, the fall is much more rapid. The water which is absorbed by the ground goes down by capillary attraction to the level of the natural ground-water, though this process is a very slow one, owing to the substratum consisting for the greater part of finely comminuted clay, and only to a small extent of intermingled sand. This fact alone explains why it is that these lakes, even when their inflow canals are closed, are nevertheless able to maintain themselves in their existing basins for years, in spite of the evaporation being so active that their water acquires a perceptible flavour of salinity, as in the Basch-köl. On the other hand it would be a mistake to say that, because the Karaunelik-köl contains a volume of 32.8 million cubic meters of water, the entire lake would, if the canal were to be kept closed, dry up by the middle of November. If the loss of volume continued to be what we have calculated it above, namely 13,115,000 cub.m. in 66 days, the lake on 5th August would have only about 19,703,500 cub.m. left, on 11th October only 6,588,500 cub.m., and on 14th November there would not be a single drop remaining. But in proportion as the surface area diminishes, the evaporation grows less, and in proportion as the substratum becomes saturated the loss by absorption likewise grows less. And yet the loss is very appreciable indeed, as we have seen from (2) and (5) in fig. 229. It may however be justly assumed, that if the lake were to remain without connection with the river for the space of two or three years, it would dry up completely, and enter the same stage as the Emin Achune-uktusu. And as we saw above, the Basch-köl, which is generally kept closed, has to be freshened up every year by an inflow from the river, otherwise its fish would die in the increasing salinity of the shrinking, stagnant water.

This circumstance affords an indication of the nature of the soil which underlies these lake-basins. If it were absolutely impermeable, that is if it consisted entirely of clay, these lakes would be far more tenacious of life than they are, and the only agency inimical to their persistence would be evaporation. This fact alone would justify the conclusion, that the lake-bottom cannot consist of clay alone, but must also be composed in part of sand, which does allow the water to filter through, though it may be very slowly. If on the other hand the lake-bottom consisted of nothing but sand, no canal would ever be able to fill the basin, but the water would be sucked up by the drouthy sand as fast as ever it poured in, and would sink down and down until it reached some layer that was impermeable. And yet this is not what really happens, greatly though one may at the first onset be tempted to make the assumption, for the bottom and sides of the Karaunelik-köl consist throughout of bare sand of precisely the same character as that of which the overhanging dunes are built up. But then it is only »secondary» sand. If we follow the first filling of a lake-basin such as the Karaunelik-köl, the order of events is as follows. According to what I have endeavoured to prove above, the underlying surface of the desert is to a very small extent undulating, so that everywhere throughout its extent there are

low oblong depressions. Now according to what we see in fig. 226, the eastern boundary wall of each bajir must consist of sand, and nothing but sand. When therefore a bajir depression, such as the Karaunelik-köl, is for the first time filled from the river, the water settles into the position indicated in fig. 230. But this position is not at all

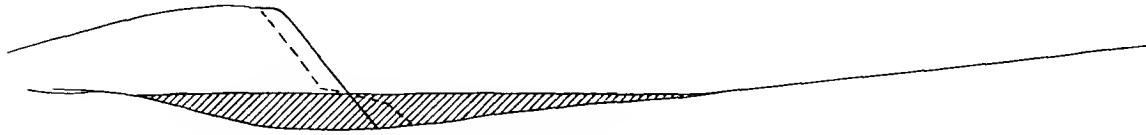


Fig. 230.

a lasting one. At the beginning of the lake's existence the ground is thirsty to the utmost degree, and if the lake is to be maintained, there must be an enormous influx of water from the river. But in process of time the walls of the basin become charged with water, and this goes on increasingly, while the capillary passages become more and more stopped up and grow more and more contracted. The influx of water from the river takes place chiefly at the two seasons of high-flood, when the current is especially heavily laden with sediment, and this gradually settles along the sides of the lake-basin. The sedimentary matter does indeed enter the lake, but it cannot leave it; it stays where it is deposited, and gradually cements the sides of the basin, and so enhances their impenetrability. In a lake which is constricted in the middle as the Karaunelik-köl is, the greater part of the invading sediment is dropped in the first and smaller basin, and especially in its northern part, adjacent to the embouchure of the canal, and in that quarter these lakes are always shallow. But for all that no inconsiderable amount of fluvial sediment is carried farther out into the lake, and even over into the southern basin; this happens especially when, the lake having during the winter or the summer fallen to its lowest level, the high-flood water pours into it like a cataract. In a word, once the lake is filled (see fig. 231), the intrusive sediment is deposited as a thin layer along the bottom, the

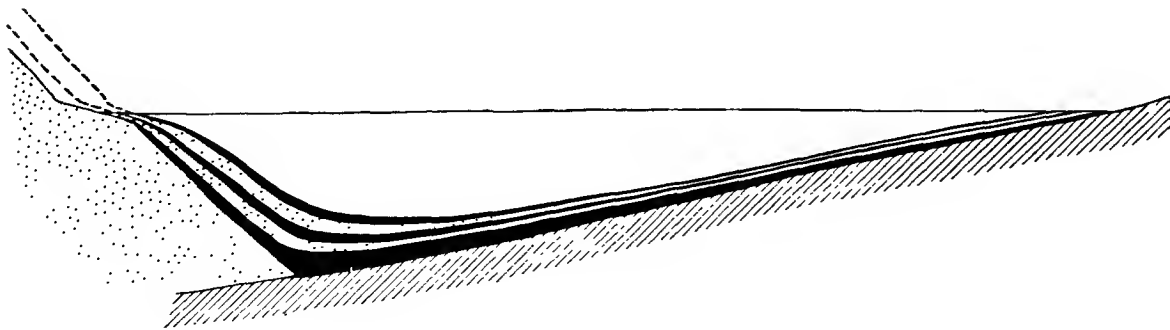


Fig. 231.

layer being of course thickest in the deepest parts. Meanwhile the onward movement of the dunes and the wave-action of the lake produce sand-slides, which cover the bottom of the lake with sand, thus burying the deposit of sediment. In a word it is a »transgression» in miniature. With the next high-flood water that enters, a fresh deposit of sediment is laid down, and this in its turn is likewise overlain with a layer of descending sand; and so the process goes on repeatedly time after time.

In the fig. (231) the alternate layers of mud and sand are, for the sake of clearness, greatly over-emphasized and shown with a regularity which they do not in fact possess, for they are of course deposited with great irregularity, and the total amount of deposit is excessively small. Yet for all that they are sufficient to act as one of the forces which co-operate to blot the lake out by to a certain extent filling it up with sedimentary matter.

The causes which contribute to make these alternate deposits uneven and dissimilar in different regions are the topographic projection of the lake, the arrangement and shape of the adjacent dunes, the direction of the wind, and the movement of the waves. Broadly speaking, the deposition of sediment takes place along the bottom of the lake, but the sedimentary layer is overlain transgressively by sand, and this takes place in all especially along the eastern shore where the dunes are advancing upon the lake. Nevertheless, as we have found to be the case in the Karaunelik-köl, it is the sand which predominates; at all events the bottom of the lake just mentioned is everywhere covered with sand. The conclusion, that the deposition of sand is greatest along the east side of the lake, is justified by the fact that, where Algæ exist, as they do in the Jangi-köl, the Baschköl, and several others, they grow by preference near the western and northern shores, where they find suitable root-hold in the fine clay, whereas on the east side the reiterated sand-slides are clearly detrimental to their growth. On the 20th May the presence of the river-mud, as indicated by the turbid condition of the water, could only be detected for about a hundred meters from the mouth of the feeding-canal. But at high-flood the mud is carried practically over the whole of the basin, the incoming water travelling in one unbroken wave to the very end of the lake. On the 20th May the water in the southern basin was as clear as crystal, all the sediment having by that time settled down to the bottom. Hence it may be assumed, that in all these lakes the greatest loss by absorption takes place in their southern divisions, for the relatively greater part of the imported sediment settles in the northern basins. And an examination *ad oculos* of the southern basin of the Karaunelik-köl suggested at once that it contained less sediment than the northern basin. In both the bajir which comes next to the Tana-baghladi-köl and in that which forms the continuation of the Jangi-köl, we find that the salt-pools (*daschis*) lie towards the northern end. It is true, we always measured the greatest depths in the southern division of the lakes, though in the two bajirs just named, whatever the cause may be, there was water in their northern parts, whilst their southern basins were almost dry.

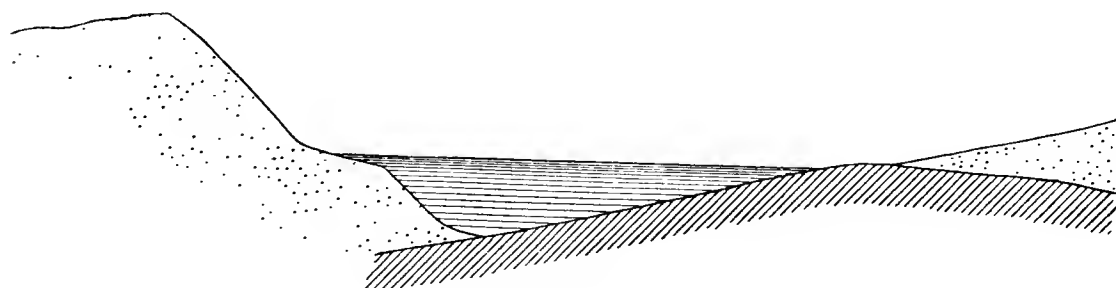


Fig. 232.

However irregular the distribution of the deposited sediment, it acts at any rate as a lining to the lake-basin, and forms a receptacle whose own superficies gradually becomes more and more impermeable, and in whose reservoir the inflowing water tends to persist for a longer and longer time. And the effect that this imported sediment produces is still further enhanced by the atmospheric dust which the storms occasion. This dust falls everywhere; but whereas that which lies on the arid ground is blown away by the next storm that comes, the dust which drops into the lake settles to the bottom, and remains there. Thus the atmospheric dust is likewise a contributory factor to the filling and levelling up of the basin of the Karakoschun, as we shall see in Vol II.

Nevertheless this lining of the lake-basin is not carried sufficiently far to put an end entirely to the absorption that goes on. The clearest proof of this is the existence of the fresh springs which trickle forth at the foot of the sandy neck that parts the Jangi-köl from its first bajir, and then give rise in the latter to a *daschi* or »salt pool», the water in which, owing to the heavy evaporation and the character of the ground, is extraordinarily salt. Precisely the same thing is repeated at the foot of the sandy ridge which separates the Tana-baghladi-köl from its first bajir. I was told that the bajir which extends south-south-west of the Gölme-käti also contains a salt-pool; this however I did not see with my own eyes. But we do have a beautiful example of the same thing in the relations which exist between the Toghraklik-köl and the depressions which form its continuation. These five depressions we saw distinctly, far below our feet, when we climbed to the top of the dune-mass which stands 560 meters from the west shore of the Karaunelik-köl, towering up to an altitude of close upon 90 m. above the level of the lake. Measured from the same point of view, the base of the leeward flank of the dune was about 185 meters distant in horizontal projection, and it is just at that spot that the deepest trench which runs through the chain of depressions is found. The direction which this trench pursues forms however an exception to the general rule. The half of the Toghraklik-köl which lies embedded in the sand does, it is true, stretch in the usual north-north-east and south-south-west direction, but its second bajir extends from north to south, though the other three lie along the usual line. The departure from the rule in the case of the second bajir is of course occasioned by the position of the axis of the dunes, and in this section their advance, for some reason or other, has not been uniform along the whole line. All these bajir depressions contain pools of excessively salt water of no inconsiderable size, and for this reason the natives designate them the Toghraklik-kölning-daschi or the Salt-pools of the Poplar Lake. The name itself indicates that the Toghraklik-köl is their »mother» lake, and that it is from it they derive their water. Their shores are absolutely barren; there does not exist a single trace of vegetation, new or old. Were it not for the inflow which is continually being received from the lake, or rather from the river, these pools would at this season dry up completely in a couple of weeks. The pool in each bajir lies nearest to its eastern side, and is encircled by a ring of almost black mud and ooze, still moist, having on the west a breadth of about a score of meters, though on the east it narrows to a few meters only. The presence of these encircling rings proves that the level of the pools had fallen some decimeters since the Tarim was in high flood; and as the same con-

ditions prevailed in all five depressions, it is evident that their pools are all connected, and that each obtains its supply of water from its nearest neighbour in the chain going towards the Toghraklik-köl. All the water in Nos. 2, 3, 4, and 5 reaches them through No. 1, whence we may infer that the salinity increases with the distance from the river. So far as I was able to see from my point of vantage, the pools in Nos 1, 4, and 5 were all pretty nearly the same size, and so too were the belts of black mud that encircled them; but the *daschis* of Nos 2 and 3 were much greater. And though these facts do not justify us in drawing any final conclusions, they do at any rate afford us this interesting fact, that the sand-free foundation of the desert, at all events so far as these *daschis* are concerned, does not rise towards the south-south-west, but the trench in which the depressions lie remains throughout at the same level, though one or the other depression may by reason of its size be deeper than the others.

The freshwater basin of the Toghraklik-köl is separated from the first of the depressions by a low *bel*, or «saddle» of sand, of the same character as that which already threatens, in the way I have described, to destroy the connection between the two basins of the Karaunelik-köl. Were it not for this saddle, the Toghraklik-köl would make one continuous lake with its five depressions, the whole containing fresh water; for the five depressions are not separated from each other by ridges of sand, but by quite unimportant swellings of the underlying stratum, which would be put under water by a very slight rise of level in the lake. From the circumstances just adduced we are enabled to draw one or two inferences of the utmost importance for an understanding of the hydrography and relief of the country. To begin with, bajirs which occur along the same uninterrupted trench lie, as already stated, at the same level, and a vertical section of the entire series, taken along its major axis, would present the appearance of a denticulated line (see fig. 233). For

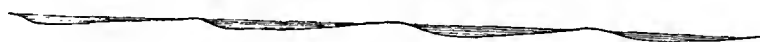


Fig. 233.

the deepest part of each bajir is found near its southern end, and the swellings which separate the several basins, equally whether they are covered with sand or not, all lie at the same level. Unless this were the case, the water of the Toghraklik-köl would never be able to find its way along the trench: its flow would be effectually prevented by a swelling of only one meter in height or by a natural dam. In the next place, we find that a ridge of sand, such as that which borders the Toghraklik-köl on the south, does not form a really effectual dam, because the water does with ease find its way through it into the first depression. Not that it is no hindrance at all, for if it were absent the lake and its depressions would, as I have just observed, form one continuous sheet of water. Its permeability is also diminished, though at an extremely slow rate, by the deposition of fluvial sediment against its northern face. Thus the sand acts as a filter; the water finds its way through it, but in so doing unloads itself of the material which it carries in suspension. One very important and obvious function however which this saddle of sand does perform is, that it forms the boundary between the fresh water and the salt. The water in

the Toghraklik-köl is continually being freshened and renewed by the inflow from the river; but the water which finds its way into the depressions is only able to leave it through evaporation. The presence of the belt of black mud round the several pools, consisting as it does of extremely fine mud, suggests, that they lose but little by absorption; the process of sedimentary cementing is so far advanced that at some earlier period they would seem to have been in much closer connection with the Toghraklik-köl. While however the lake is surrounded with vegetation, amongst other forms with poplars, as indeed its name implies, the immediate vicinity of the depressions is perfectly barren. There cannot exist a doubt that in the future these basins will be entirely cut off from all connection with the lake, and will no longer be fed by any transmission of its water; they will then attain the same stadium as the bajir of the Jangi-köl, which contains but one quite insignificant pool. They will gradually dry up one after the other, and their floors will then resemble the ordinary bajirs in the interior of the desert.

The communications between the depressions thus stretch from north-north-east to south-south-west, but do not extend to either side. This is sufficiently established by the fact which we have already ascertained, namely that damming the Basch-köl has no influence upon its neighbour, the Jangi-köl. The Gölme-käti again is full of water, while the bajir of Emin Achune-uktusu, situated barely a kilometer to the east of it, is dry. The water in the Karaunelik-köl is perfectly fresh; but the *daschi* of its neighbour, the Toghraklik-köl, on the west, are impregnated with salt. If now the sandy thresholds which lie across the south-south-west extremities of these lakes are permeable, why are those which lie east and west of them impermeable to it? There exists no reason to suppose that they have been cemented to any more appreciable extent than the southern slope of the lake; rather is the contrary true, because of the transgressive sand-slides which come down the leeward flanks of the dunes. If the substratum were everywhere perfectly flat, then all these lakes would communicate one with another and their water-levels would everywhere be the same.

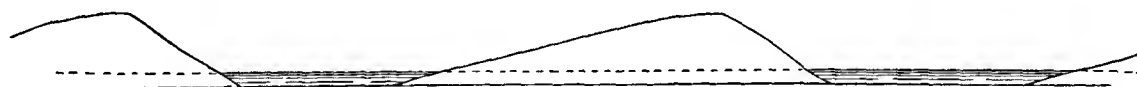


Fig. 234.

But as this is not the case, it follows that the underlying stratum must undulate, in the way we have already assumed; and the cross-section is that depicted in fig. 235



Fig. 235.

Thus, owing to the presence of water in the depressions which lie nearest to the river, we are able, without going to the trouble of carrying through a laborious and trying survey, to draw direct conclusions as to the character and properties of the relief of the desert. Broadly speaking, and in outline, the relief is as shown in



fig. 236. That is to say, the floor of the desert is grooved by long furrows or trenches, which run parallel to one another from north-north-east to south-south-west.

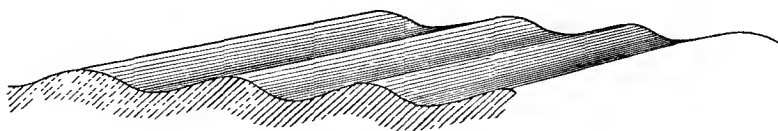


Fig. 236.

Each such furrow or groove contains a series of bajirs or depressions separated from one another by projecting ridges of sand. The depressions which lie nearest to the river are filled with water; but the water-filled basins in the different parallel trenches are unable to communicate with one another, and a proof of this is that, whereas some contain fresh water, others contain salt. Hence they are effectually bounded east and west, and in those directions are sharply separated the one from the other. The positions which the dunes occupy with regard to these underlying undulations are indicated in fig. 237. I have already pointed to the fact, that this regular grooving of the face of the desert is caused by the wind; but to this we shall return again in another connection.

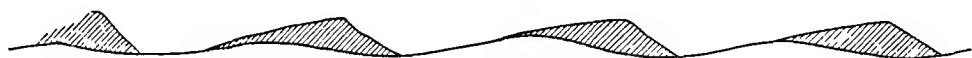


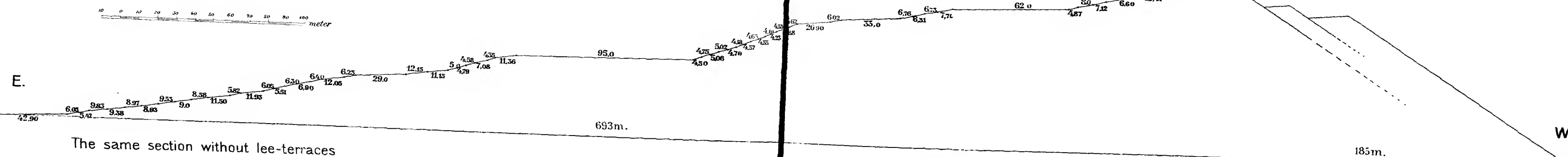
Fig. 237.

Here it would perhaps be desirable to say something about the properties of the water contained in these lakes. It is self-evident, that in a lake which has no discharge, and which fills an impermeable basin, so that it diminishes, not through absorption, but through evaporation alone, the water must in time become salt, and that the salinity must increase with the age of the lake. But we find that the water in these lakes is perfectly fresh, at any rate to the taste; consequently this must be due for the most part to the percolation of their water through the soil. And in fact they are refilled every year, and may indeed be considered to possess underground drainage. Now it is perfectly obvious that a lake which has a cubic capacity of 32,800,000 cub.m., and yet receives annually 70 million, of which probably one-half is lost in the ground, will increase in salinity at an exceedingly slow rate. And seeing that these lakes are relatively recent creations, as also that their levels are in great part regulated by human agency, it is clear that their salinity will augment with extreme slowness. And yet they do grow saltier, as is proved by the Baschköl. Richthofen, starting from Prschevalskij's statement, that the Kara-koschun is a freshwater lake, concluded that it must therefore be of recent origin. This reasoning is also applicable to the lakes we are discussing, for they are of even more recent origin than the Kara-koschun. Indeed both these circumstances serve to explain the freshness of the water in them. But of the two factors their comparative newness is by no means so important as the factor just alluded to above, for no matter how old they are, so long as they continue to receive the same



Vertical section of the dune-accumulation  
between Karaunelik-köl and Toghraklik-köl

Scale 1:2000

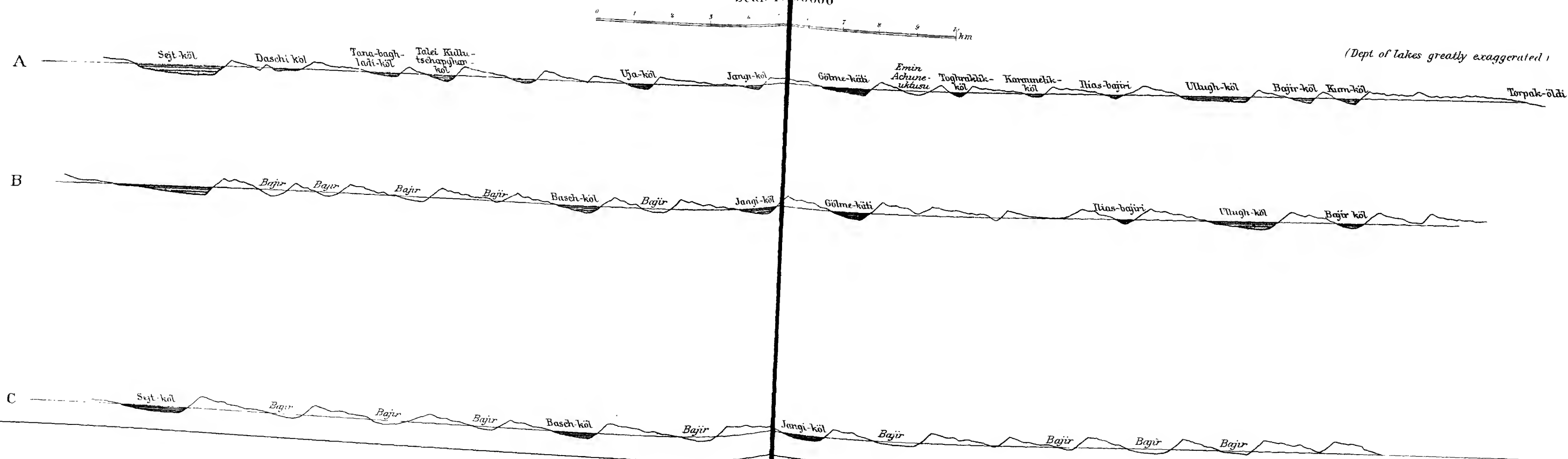


The same section without lee-terraces

Vertical section of the southern basin of Karaunelik-köl and its dune-accumulations

Vertical sections along the lines A.B and C on Pl. 49

Scale 1:100000





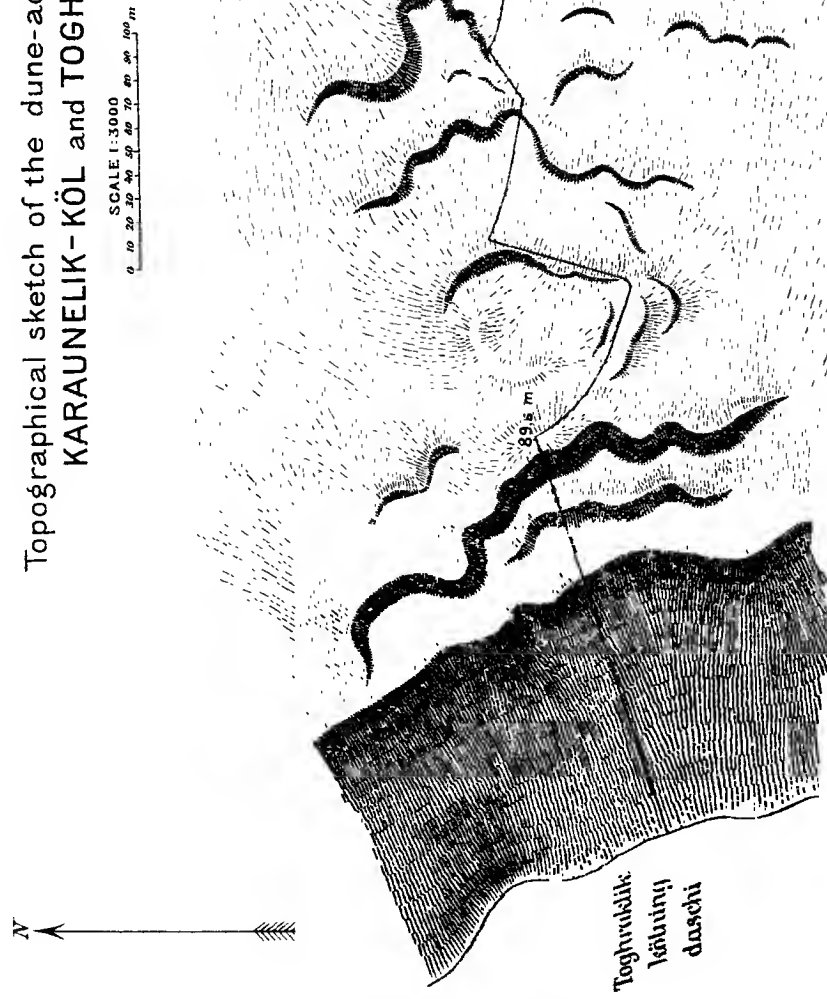
amounts of fluvial increment as they do now, they will never become so salt as, let us say, the self-contained Tibetan lakes, which in proportion to their volume are the recipients of quite insignificant quantities of fresh water. The lakes which lie in the clay and sandy deserts of Central Asia may in fact be regarded as the final expansions of the river which forms them, such as the Kara-koschun, and, in part, as marginal lakes which are intimately connected with the river, like those we are discussing. In both cases the lakes form so intimate and so integral a part of the river-system, that its properties must to a very great extent be further propagated in them.

From the map of this desert lacustrine region it is evident that the intervals between the lakes, bajirs, and daschis are filled by immense dune-accumulations, likewise arranged in long parallel lines that run north-north-east and south-south-west. These dune-accumulations, like the lakes, vary in breadth; and as the lakes differ in point of depth so also do the dune-accumulations differ in altitude in different localities. Pl. 43 shows in section the outline of the chain of dunes between the Karunalik-köl and the inner depressions of Toghraklik-köl. I traversed them from east to west with a levelling-instrument. The reflecting level was 1.47 m. above the ground; every point therefore along the sectional line indicates an observation taken at that level. The distances between the points of observation were measured with the tape. The support of the reflecting level was prevented from sinking into the sand by a metal disk placed under its lower end. The line of traverse started from the Muptu Achune-modschughu, and on the whole proceeded westwards, although once or twice I was compelled by the conformation of the dunes to deviate to the south. But these deviations I disregarded in drawing the sectional line; it is to be regarded as virtually a straight line. And there is also one other respect in which the section is not quite accurate, in that it indicates only the step-like ascent of the normal 1.47 m. from point to point, and ignores the irregularities of the sandy surface, its convexities and concavities, between point and point. The features of the contour are however indicated to some extent in the little topographical sketch on Pl. 44, which shows plainly the deviations from the straight line of traverse. To begin with, at 42.9 m. from the shore we have an elevation of 1.47 m. above the lake-level. This stretch, covering the strip of shore, is almost entirely free from drift-sand. But to reach the beginning of the next step, or the foot of the second level of 1.47 m., we only advanced 6.05 m. After that the steepness of the dunes varied, and consequently also the distance between our points of observation. The shortest distance between any two such points was 4.10 m., indicating a pretty abrupt rise of contour. The intervals lay for the most part between 5 and 8 meters, and as this very appreciable steepness was on the windward side of the dune, it suggests that the wind must also blow there from other directions than the prevailing east-north-east quarter. Although the shape and other properties of a dune-accumulation such as this must to a great extent be dependent upon the shape of the individual dunes which compose it, in that they partly melt together, and so lose their characteristic peculiarities, and partly are distorted by sudden gusts and deviations of the wind from its prevailing direction, nevertheless it is easy to see that there are two different kinds of dunes or two different types, which recur time after time with more or less distinctness.

One type or variety consists of long-backed ridges or swellings, elongated east and west, with rounded, often quite steep, slopes on every side. They possess no sharp edges anywhere, and have no distinctly marked leeward flank, but on every hand display softly rounded and beautiful outlines, and gently melt together with their neighbours. The other type or variety is the usual one, regularly formed and linked together, crescentic in shape, with a steep leeward flank on the west and a long gentle slope on the east. These dunes stand relatively isolated, or rather as it were piled up on the main body of the dune-mass, where they are more directly exposed to the prevailing wind, and thus their leeward slope forms a concave, curving front; but where several such dunes grow, as it were, together, and become welded into one continuous dune, in that case their leeward flanks form a straight uninterrupted wall, where it is quite easy to see the slight festooning of the line of their bases. The smaller the dunes and the less intimately they are linked together, the more plainly this festoon arrangement is shown; and the closer they are fused together, as for instance at the western edge of the dune-mass, the straighter is the line of their bases. Another characteristic feature is the steep leeward flank which is turned towards the south, pointing to the presence of northerly winds. Strangely enough, this particular feature is more especially developed in those localities in which the dune-mass is lowest, that is to say in the parts which lie nearest to the lakes. As my topographic sketch shows, the first traverse of my rough survey was made along one of these steep leeward faces, where the angles of inclination were  $32^{\circ}$ ,  $39^{\circ}$ , and  $37^{\circ}$ . The middle of these was the steepest angle I measured anywhere in this desert. The long-backed dunes have an angle of inclination of  $25^{\circ}$  and  $26^{\circ}$ ; but as a rule the slope up the dunes is generally  $15^{\circ}$ , except at the apex of the dune-accumulation where the angle flattens out to  $3^{\circ}.6$ . Beyond this over on the other side the surface droops sometimes one or two degrees towards the brink of the sharp edge whence the sand plunges over on the leeward slope. The total length of my line of traverse was 693 m., or making allowance for my deviations south, the length of the windward slope was 558 m. The mean angle of elevation from the foot of the dune-accumulation to its crest was  $9^{\circ}.20'$ .

The most characteristic features, not only of this particular dune-mass, but also of all the others in this great desert, are the up-towering leeward faces, extending from north-north-east to south-south-west, and consequently fronting west-north-west. The accompanying section shows this in the most conspicuous way; it is taken from the point where in the extreme west the dune goes down to the bajirs of the Toghraklik-köl. If the slope were taken straight from the summit to the base, its horizontal projection would measure 145 m., but in point of actual fact the slope is interrupted in two places, and descends by two gently inclined terraces, so that the actual projection measures 185 m. My sketch is however only a transverse section of the dune-accumulation as a whole; but the topographical sketch shows that there are five other places, lying east of the accumulation, at which the dunes turn their steep leeward slopes towards the west. Hence the general outline of the front of the dune-mass is that shown in the accompanying sketch (fig. 238) that is to say, it resembles a curving saw-blade. The architectural laws which prevail everywhere throughout the dunes are not difficult to recognise, but it is not always easy to say what are the causes

Topographical sketch of the dune-accumulation between  
KARAUNELIK-KÖL and TOGHRALIK-KÖL.







of the exceptions to them. On the windward slope of the dune-accumulation we have established the presence of a system of leeward faces looking towards the south. These are occasioned by northerly winds, are steep and short, and exercise no influence upon the contours of the dune-accumulation as a whole. But how are we to explain the presence of the two terraces between *f* and *g* and *g* and *h* on fig. 238? Only a short

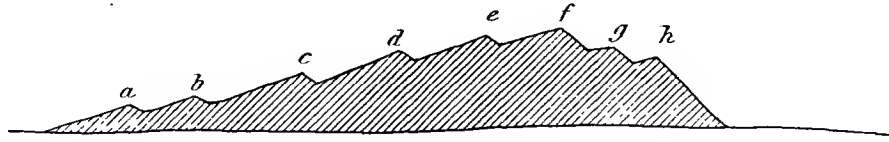


Fig. 238.

distance to the north of where the section was taken there is but one terrace, and still farther north none at all, but the leeward flank descends as usual, at an angle of  $33^\circ$ , straight into the depressions of the Toghraklik-köl. In the first place it is essential to remember, that each of the sharp crests *a* to *h* in fig. 238 may be regarded as belonging to as many separate individual dunes, all moving in common towards the west and, so to speak, climbing up upon one another's shoulders. Consider the situation as depicted in the fig. The dune crest *f* is the highest, forming as



Fig. 239.

it were the culminating-point of the whole of this particular accumulation of sand. If we assume that the maximum vertical altitude of each of these masses of sand is in general 90 m., then the culminating-point *f* is situated in the atmospheric stratum (I in fig. 239) which has experienced the least resistance from the chains of dunes situated to the east of it. This is precisely the point therefore throughout the whole of this dune-accumulation which is most exposed to the effect of the wind; and the very gentle slope of  $3^\circ$  to  $4^\circ$  on its summit proves also, that this particular part of the dune-ridge has suffered most from the frictional power of the wind. This individual dune must therefore move at the swiftest rate, at all events swifter than *g* and *h*, which are both of them sheltered from the wind. If then it travels faster than *g* and *h*, it must eventually overtake them, and melt and fuse with them, a stage which is represented in fig. 240. At the moment it fuses with them (fig. 241) its

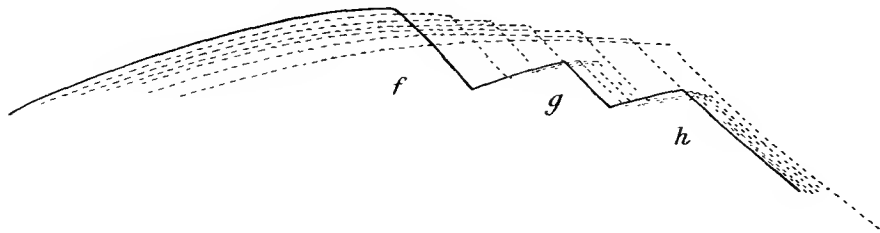


Fig. 240.

swiftness is retarded, since the sand which topples over has to cover a surface which measures about 165 m. in breadth from  $f$  to the base of the dune. Each successive layer of sand that descends is therefore extremely thin, and its advance is slower than that of the dune  $e$  which follows immediately after it, and which

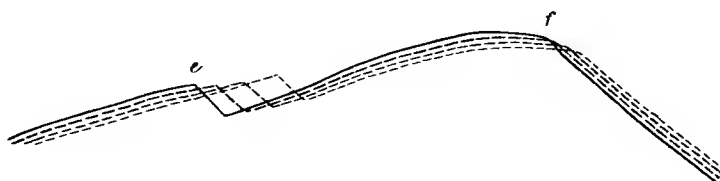


Fig. 241.

moves faster owing to its leeward flank being far shorter, not more than a dozen meters at the most, while in its case each succeeding sand-slide forms a much thicker layer than happens in the case of  $f$ . But as at this stage  $f$  lies more exposed to the wind, its windward slope becomes in consequence more and more flattened, until eventually as compared with  $e$  it lies in a more sheltered position than  $e$  does. This last then becomes the culminating-point of the dune-accumulation, while it and  $f$  become separated by a terrace, which has quite as ephemeral an existence as its predecessor. And if the dune-crest  $d$  (fig. 242) should rise to the culminating position before  $e$  overtakes  $f$ , then there would be two terraces.

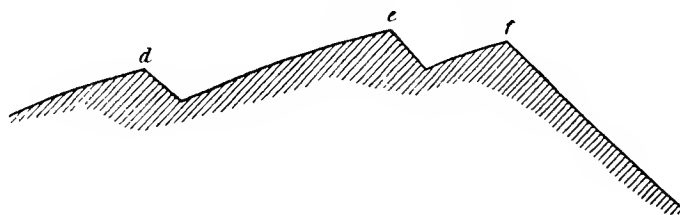


Fig. 242.

To return to fig. 238,  $e$  must move slower than  $f$ , because it is exposed to an atmospheric current which in its passage over the earth's surface has encountered more opposition than the current which sweeps over  $f$ . In a similar way  $d$  travels more slowly than  $e$ , and so on. Nevertheless this has no effect upon the general advance of the dune-mass, for as soon as  $f$  has overtaken  $g$  and  $h$ , its own forward movement becomes so retarded that the individual dunes which follow on behind it catch up with it. There is no need therefore to assume that the base of the leeward flank of the accumulation moves westwards intermittently, or by successive spurts as it were. The crest  $h$  (see fig. 240), lying under the shelter of  $f$ , does thus indeed travel more slowly, but it does not therefore necessarily follow that it advances generally at a slower rate than the crest  $f$  (fig. 241), because the slope of this last is longer than the corresponding slope of  $h$ .

The entire dune-mass moves therefore slowly towards the west. The individual dunes, which, under the driving impulse of the east wind, climb up upon its shoulders, travel far faster than it does, pass each in turn the culminating-point, and over on its leeward face are swallowed up by their comrades following on behind them.

The combined system of movements forms as it were an orbital revolution in a vertical plane, but the movement is confined entirely to the surface, the interior of the mass being immovably stationary. The movement of the dune-mass as a whole resembles that of a viscous porridge rolling on over itself again and again.

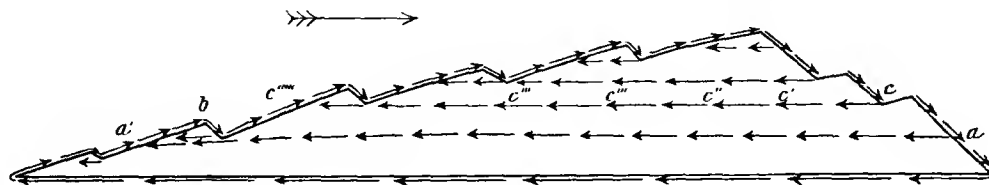


Fig. 243.

Fig. 243 illustrates the progress of individual particles of sand in different parts of the composite dune. A particle which happens to fall at the base of the leeward slope has to remain there until the whole of the dune-mass has travelled on over it. A particle which comes to rest at *a* becomes again involved in the revolution when it gets to *a'*, and no sooner does it attain to the crest *b* than its movement becomes greatly quickened; nor can it again penetrate to the interior of the dune-mass until after it has traversed a great number of triangular paths. And it is not until after

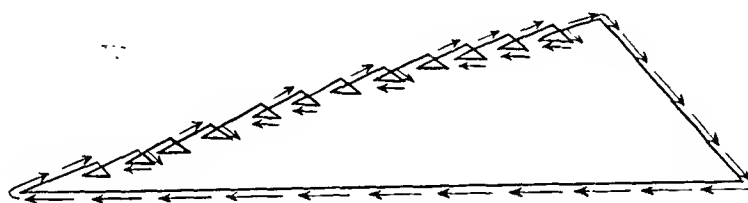


Fig. 244.

the crest *b* has passed the culminating-point that our particle definitively comes to rest on the main leeward side, and there lies for a longer or a shorter period motionless in the interior of the dune. Suppose it to rest in the position *c*, then the successive positions it assumes relative to the general forward movement of the dune-mass are represented by *c'*, *c''*, *c'''*, *c''''*, *c'''''*. Upon reaching *c'''''*, it again enters upon the long series of triangular paths, until eventually it once more attains the summit or culminating-point. The nearer therefore the particle lies to the substratum, the longer will be the period during which it will remain at rest. Within the mass of the individual dune to which it belongs, say for instance *b* in fig. 243, the movement of each particle coincides exactly with its movement in the dune-accumulation as a whole. In a dune which has a slope of  $9^\circ$  on the windward face and a slope of  $33^\circ$  on the leeward face, and which stands upon a perfectly horizontal base, the path pursued by an individual particle will be as follows — (1) upwards and forwards at an angle of  $9^\circ$ , and that with almost the speed of the wind; (2) downwards and forwards at an angle of  $33^\circ$ , with the speed of natural gravitation, or rather of a slide; (3) at a standstill, which as compared with the general movement of the dune-accumulation may be likened to a retrogression on a horizontal plane, though at an inconceivably slow rate. If the leeward slope of the dune overhangs a lake, as it does

on the east shore of the lakes we are discussing, then the nature of the advance is somewhat altered. If a dune descends precipitously into a river, as indeed often happens in the easternmost arms of the Tarim system, e. g. the Ilekk, then the particle is gradually drawn out of the progressive revolution, the dune becomes stationary, and it is only on the windward slope that the usual conditions prevail. The dune acts as a sort of barrier, which the drift-sand has to pass on its way into the river. The core of such a dune as this may thus remain for a long period unchanged, the reiterated renewals and movements being confined entirely to its surface. In the case



Fig. 245.

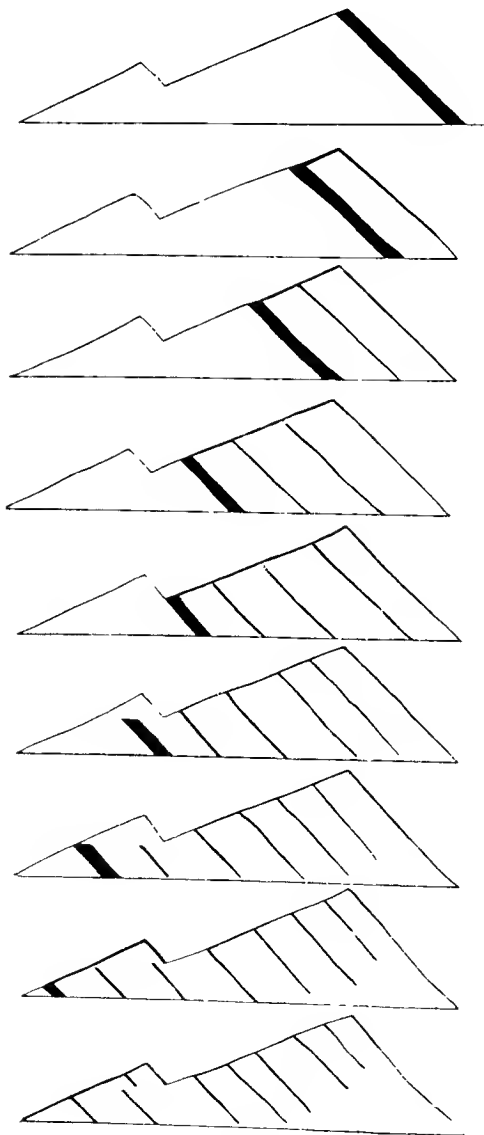


Fig. 246.

of a simple individual dune the paths of movement of three separate particles of sand, situated at 1, 2, and 3, in fig. 245, will coincide with the paths of the points 1<sub>1</sub>, 2<sub>1</sub>, 3<sub>1</sub>. The fig. 246 illustrates an experiment which it is impossible to carry out, because it requires as an indispensable condition a period of 50 to 100 years for its accomplishment, and a power of vision capable of penetrating to the heart of a sand-dune, so that it is here only carried through in imagination. If now we suppose that, on the leeward flank of a dune-accumulation, there is a layer of black sand about two meters thick, superimposed upon the ordinary yellow sand, then in process of time the black sand would, in consequence of the dune's advance, become distributed through its interior in the manner shown in the illustration. The different stages are supposed to take place at intermittent intervals, though in point of actual fact the intermingling of the sand goes on uninterruptedly in frequent thin layers, all lying parallel, as shown in the series in the fig. The farther the dune advances the greater is the quantity of yellow sand that becomes intermingled with the black, which thus becomes distributed and thinned out through the interior of the dune in the manner indicated in fig. 247. By the time the entire dune-accumulation has advanced a distance equal to its own breadth, the original black layer has

been disseminated throughout the whole of the interior of the dune, and the intermingling approaches nearer and nearer to perfection the longer the advance continues. Also, the process, illustrated by this single example, is rendered increasingly more complex in proportion to the number of individual dunes which make up the dune-accumulation; further, the example just dealt with takes no account of the diversities of bedding and intermingling which are occasioned by the varying size of the particles of sand.



Fig. 247.

Meanwhile, however, we have travelled a very long way from the steps or terraces to which I called attention on the leeward flank of the dune-accumulation. The object of the arguments adduced above has been to justify my opinion, that the presence of these terraces may be taken as a proof of the westward migration of the dune-accumulations.

Along the 693 m. line of traverse there are 61 points of observation, and the culminating-point lies 89.5 m. above the level of the Karaunelik-köl; though from that point I was able to observe with the reflecting level, that there were two or three other summits which exceeded it, yet only by a few meters. No summit within my range of vision was, I am sure, higher than 100 m. Assuming that the *daschis* of the Toghraklik-köl lie at the same level as the Karaunelik-köl, and assuming that the leeward slope goes down from the summit to the foot without interruption (terraces), then the length of the slope would be 170 m. The two opposite slopes, windward and leeward, thus measure 558 m. and 170 m. respectively, and consequently, proportionally expressed, are as 3.28:1, or in other terms, the windward slope is 3.28 times as long as the leeward. But in point of actual fact, the latter, by reason of the terraces, is just at this point about a score of meters longer.

The map of this lacustrine region conveys the impression, that the lakes are larger than they actually are, and that the strips of sand which intervene between them are of relatively insignificant proportions. A similar impression is produced by the vertical section through the southern basin and western dune of the Karaunelik-köl, where the lake is more than twice as wide as the dune. But when we take the cubical capacity into account, the facts are seen to be otherwise. We have ascertained that the Karaunelik-köl is capable of holding 32,818,000 cubic meters of water. If now, for the sake of comparison, we consider the volume of the dune-accumulation for a distance of 5.2 km., which is also the length of the lake, and take it that the crest is everywhere 89.5 m. above the level of the latter, and that the breadth is uniform throughout, namely that of the line of traverse, or 693 m., then the cubical content of the dune-accumulation will equal 161,000,000 cub.m., or five times the capacity of the lake. But the breadth of the dune is not uniform any more than the breadth of the lake is. My line of traverse crossed the dune at its narrowest point, just where the lake, on the other hand, was broadest; but at the sound between the northern and the southern basin, where the lake has a breadth of only 300 m., the breadth of the dune is approximately 1500 m. Thus, as a matter of fact, the cubical content of the dune is very much greater than the result I have obtained above. On the Plate 43 I have endeavoured to draw three vertical sections right through

the entire length of this lacustrine region; it does not however possess more than an approximate value, and is designed to afford only a general idea of the relief of the surface.

Viewed from the culminating-point of the dune, Jolsis-kakmasi, the deep bay on the east side of the Gölme-käti, lay S 80° W. This was the only part of that lake that was visible to us, because just there the intervening sand was low, at all events considerably lower than our point of observation; for not only is each chain of dunes subject to great variation as regards its ground-plan, it also varies greatly in its altitude. Towards the south stretched an illimitable »ocean» of sand; but the established characteristics of the dune-architecture persisted unchanged to an almost infinite distance. Of the bajirs we could of course see only those which were close under our feet, those farther away being masked by the sand. On the other hand the steep leeward flanks stood out with especial distinctness, appearing, with the sun behind them, like straight lines of impressive blackness. West of each such frowning wall we concluded there was a bajir, a valley or trough, between two vast accumulations of sand. And even in the two *daschis* which lay immediately beneath our feet, we recognised again two or three features which we had observed in the Sejt-köl, the Gölme-käti, and the Karaunelik-köl. They too, like these latter, each consisted of two basins, and if they were filled with water they would, like them, possess a *bolto* or »connecting sound».

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## CHAPTER XVIII.

### THE ULLUGH-KÖL AND BEGELİK-KÖL.

The Tajiri-kakmasi, the next lake south-east of the Karaunelik-köl, is quite a small lake. Its first bajir is called Ilias-bajiri; its second, which is very long, bears no name.

Next comes the Ullugh-köl, which I mapped and sounded on the 21st May. This lake, which stretches almost due north and south, at all events with a smaller inclination westwards than usual, is fed by a short canal, through which the current was running at a lively rate. The words Ullugh-köl mean the Big Lake, and the name is so far warranted, that the lake is at all events bigger than its neighbours. On this occasion too our work was hampered by the wind, coming from the south-west, an unusual quarter, at any rate at that season of the year. It blew most irregularly, violent gusts sweeping across the lake time after time, while in the intervals between it would be perfectly calm. Still, even this was sufficient to alter to a certain degree the slope of the summits of the dunes, by sculpturing a steep sort of cornice or shelf on the exposed side near the top. The annexed fig. shows the dune in



Fig. 248.

vertical section. The cornices thus formed go on increasing in width as long as the wind continues to blow. Nevertheless the change effected in the relief of the dune-mass as a whole is very small; at the most its advance is only checked to a very slight extent. The effects produced by this south-westerly wind would be obliterated by an easterly tempest in the space of an hour. The difference between these two winds is therefore this, that from the east the wind often continues for 48 to 60 hours without intermission, whereas from the south-west it is seldom steady, but comes in gusts or squalls. But relatively slight though this south-westerly gale was, I found, upon walking across the dune-accumulation on the western shore of the lake,

all too evident proofs of its effect upon the surface: we were obliged to climb over all the little leeward ridges which it had blown up in our path. Each of these was crowned by a cloud of sand, hovering above it like a plume, at first at the same angle as the windward side of the dune; but this soon yielded to the pressure of the wind, and disappeared, dropping into shelter. Close to the dune-crest these outstanding clouds of sand shone with an intense yellow colour, as though they were so many overhanging roofs. On the tops of the dunes the sand particles are wedged tight together, and the surface is hard; but in between the parallel ridges it is so loose that one sinks in when walking across it. When these dune-valleys dip down sufficiently low, one gets almost absolute shelter from the storm, scarce any trace of the wind being felt. In a similar way there was a narrow strip along the western shore which was screened from the wind, but out in the middle of the lake the waves were running so high that the unsteady canoes were scarcely able to face them. The darker portions on fig. 249 indicate the parts which are sheltered from the south-west wind, and fig. 250 those, sheltered from the east-north-east wind.



Fig. 249.

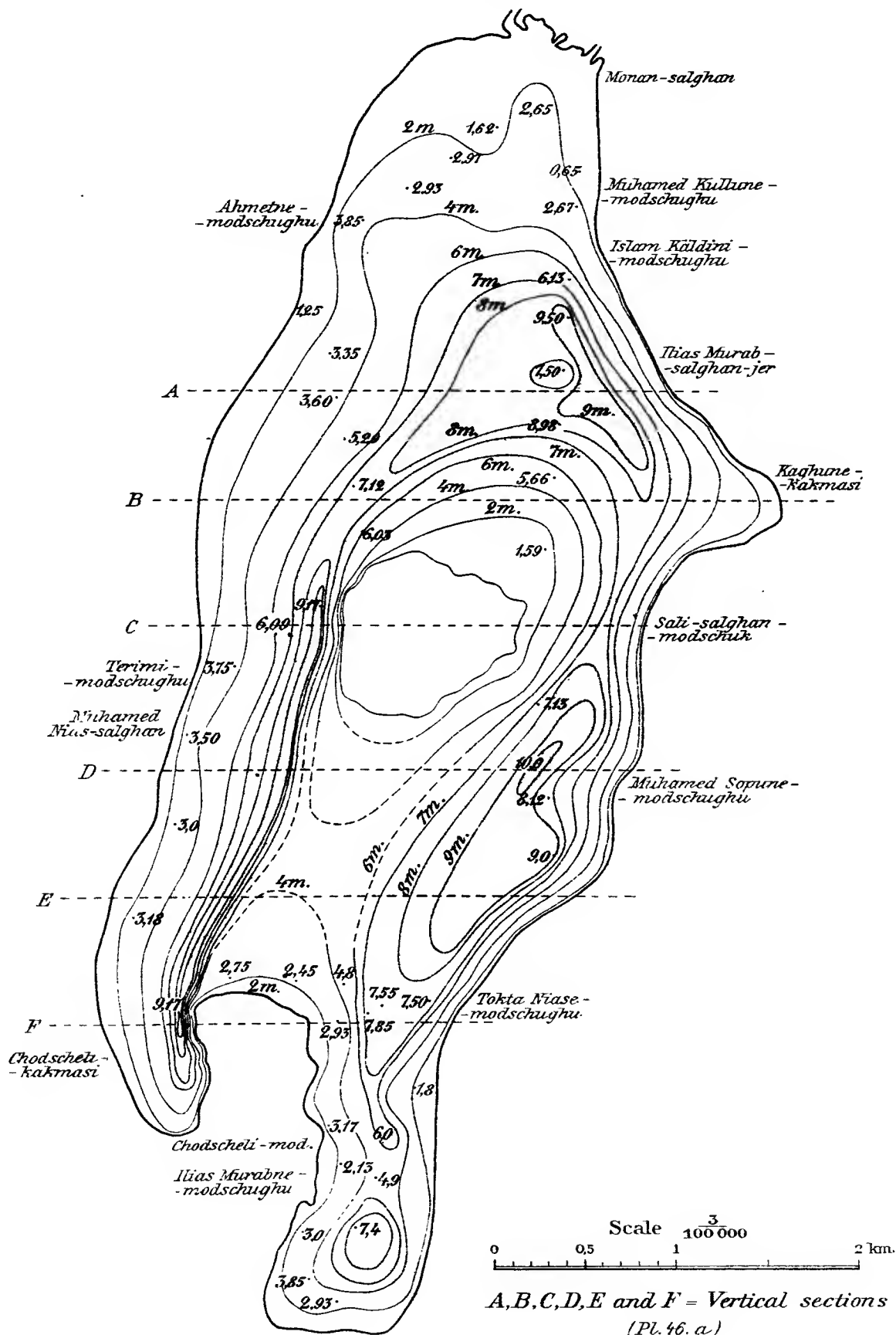


Fig. 250.

In shape the Ullugh-köl is peculiar, resembling none of the lakes I have already described. Roughly speaking, it forms an elongated ellipse. Instead of being divided into two basins, with a *bolto* or »sound» in the middle, it is there broadest, and it contains a sandy island, exhibiting precisely the same form as the accumulations of sand which separate the troughs or trenches of the different depressions from one another. That is to say, it has a flat slope on the east and a steep western face, the eastern shore plenteously covered with reeds and bushes, the western almost completely bare. Without doubt this island is also travelling westwards; but as it advances it must inevitably diminish in height, for immediately in its path lies one of the deepest parts of the lake. In accordance with the conclusions we have already drawn, it ought theoretically to be eventually converted into a peninsula jutting out from the eastern shore. Simultaneously with that the lake will become divided into two basins by the bolto which will then be formed. The topographic projection of the island is such as might be expected in the case of a dune-dome covered by water, namely triangular, with its base parallel to the west. It is encompassed by deep water on all sides except on the east-north-east, next Ilias Murabne-salghan. And that such is the state of things might almost be inferred directly from the map. For to the east-north-east of this point there is a bay, Kaghune-kakmasi, penetrating deeply into the eastern shore, to which there corresponds a saddle or depression in the crest



# Isobathic map of Lake Ullugh köi





of the dune beside it. Along this line therefore the prevailing easterly wind is able to sweep along comparatively unchecked. The consequence is, the dunes on the island travel towards the west-south-west, and the backwash of the waves suck the sand into the lake, making it shallow. The island lies about the middle of the lake, rather nearer the eastern shore, and forms the continuation of a very sharply outlined peninsula, which divides the southern part of the lake into two rounded bays. We have a similar conformation in the Gölme-käti: it is a cleavage, pointing to two depressions with a truncated dune-length lying in between them, in other words, a dune-length that dies away wedge-shaped towards the north. South-south-west of the larger bay, the one on the east, there is a bajir containing a shallow salt-water lake, with a bottom of almost perfectly black ooze. The sandy isthmus which separates the lake from this bajir is very low, and is covered with kamisch; and even on its face there lie two or three small sheets of water resembling detached portions of the lake or of its bajir. Beyond this last again, and in the same south-south-west direction, it is evident, from the low sand, as well as from the steep westward flanks of the dunes, that there must be several other bajirs lying in a string. From a high point of view to the south of this lake we saw in the N.  $60^{\circ}$  E. a large bajir full of water, belonging to the lake of Bajir-köl, or possibly forming a part of it. This is said to be long and narrow, and to be divided into four basins by three *bolto*s or »narrow sounds». From a cape called Terimi-modschughu, which projects from the west side of the Ullugh-köl, I climbed on foot to the summit of the dune-accumulation, whence I had a magnificent view of the large and elongated bajir which belongs to the lake of Tajiri-kakmasi, forming its south-south-west continuation. In this depression there is a good deal of salt water, its situation indicating the usual conformation of the underlying contours; that is to say, along its west side there is a broad band of black, moist ooze (*schor*, *patik*), from which the water had recently receded, whereas the strip along the eastern shore is either extremely narrow or altogether wanting. In its place we have between the water-line and the foot of the dunes a belt of reeds and bushes 50 m. broad. About midway along the west side there is a flat table-topped elevation, 2 m. high, and formed of clay. Similar phenomena, to which the natives give the name of *gumbes*, or the »tower», occur sometimes a long way into the desert between Jangi-köl and Taran. They belong to the substratum, having hitherto successfully defied wind, corrasion, and disintegration, but it is evident that their days are nevertheless numbered. The level belt of sand-free soil on the left side of the Tajiri-kakmasi is exceptionally broad; and I have already mentioned the broad band of barren ooze. On the inner or western side of this last there exists a still broader belt of reeds, to the edge of which the high water appears to rise. The culminating point of the western dune-accumulation lies to the S.  $80^{\circ}$  W.; and in the S.  $52^{\circ}$  W., on the other side of a low saddle in the sand, we perceived another bajir; but beyond that we were unable to see owing to the air being filled with dust. Although the first bajir extends on the whole from N.  $15^{\circ}$  E. to S.  $15^{\circ}$  W., its southern part is nevertheless irregular in outline, in that its greater basin inclines away to the south-east and east, and is said to form a continuation of the western bay of the Ullugh-köl, from which it is however separated by a low sandy isthmus. The narrowest part of this bajir, again, also as-

sumes an unusual and peculiar shape, having some curiously irregular peninsulas and islands of silt, which appear to indicate that the watery covering is exceptionally thin. But north of these three come other peninsulas which are remarkable for their regularity of outline, being shaped like long, narrow piers. Two of these incline towards each other like the carbons in an arc-light, while a third is broken off short. They stretch from south-west to north-east, and consequently are not quite parallel with the major axis of the lake. There can be no doubt that they are part of the original substratum, being ridges, abraded by the wind, of the same kind as the *jardangs*, which are so characteristic of the Lop Desert. And with these latter they do exhibit a parallelism in direction.

With regard to the vegetation beside the Ullugh-köl, I may add, that poplars occur on both shores in small clumps, and are relatively numerous in the sheltered bay of Kaghune-kakmasi. *Jäkän* or »sedge» is scarce, growing on two or three promontories only. On the other hand reeds are very plentiful; they occur on the dry strip of shore at the level of the existing water. But whereas they are scanty along the east shore, and for long distances absent altogether, on the opposite side of the lake they are so dense that in many places they form thickets which are absolutely impenetrable; and the same remark applies to the west shore of the



Fig. 251. DIFFERENT POSITIONS OF DRAG-NET AND CANOES IN FISHING.

eastern bay. But these belts of reeds are very narrow. At the last high-flood season all these reeds stood in the water, for, as was quite evident from the marks on their stalks, the lake was then 1.345 m. higher than at the time of our visit; and of course the lake's area was at the same season considerably enlarged. Those parts of the

shore which had on that occasion been inundated were still moist. The fauna was represented by roe-deer and wild-boar; we shot one of the latter whilst it was on its way from the lake to the river. The only birds we were able to descry were eagles and water-wagtails. Mollusk-shells littered the shore in places. The Ullugh-köl is said to be plentifully stocked with fish, but the fishing is only carried on after the river has dropped sufficiently to cut off its own connection with the lake. The fish are taken here by a different method from that employed in the lakes with which we shall make acquaintance presently. Whereas in these last they are caught by nets stretched across the narrow »leads», or water-channels, amongst the reeds, in the Ullugh-köl they are caught in drag-nets, which are said to be as much as 60 fathoms (*kulatsch*) long, and are drawn in the wake of a couple of canoes. When the net is extended so as to form a semicircle one of the canoes rows inwards, until the net forms a spiral, while the crew of the other canoes frighten the fish into it by beating the water with their paddles, and when the fish get fast in the meshes, they are lifted on board, and killed by striking them on the head with a club. But owing to the unseaworthiness of the canoes, the fishing cannot be prosecuted when the wind is strong.

As in the case of the Gölme-käti and the Karaunelik-köl, the Ullugh-köl has a topographical nomenclature of its own. Beginning at the north end, and pro-

ceeding south along the east side, we have Monan-salghan amongst the tamarisk-cones and reeds; then the cape Muhamed Kullunu-modschughu and Islam Kældini-modschughu; Ilias Murab-salghan-jer (the Place Settled by Ilias Murab), Polotto-boltasi (the sound between the island and the shore); next the bay of Kaghune-kakmasi, already mentioned; Sati-salghan-modschuk (the Cape at Sati's Settlement); Muhamed Sopune-modschuk; Tokta Niasi-modschuk; and Abdu Semet-kakmasi, the name of the eastern bay at the south end. On the west side of this last are the capes of Ilias Murabne-modschughu, Chodscheli-modschuk, and Koghune-mudschuk. The name of the western bay is Chodscheli-kakmasi. Proceeding up the western shore we come successively to Muhamed Nias-salghan, Terimi-modschuk, and Ahmedne-modschughu. The island in the lake has no special name, but is generally spoken of as the Kum-aral or Sand Island. A cape which juts out at its northern end is however known as Ilias Murabne-salghan, and another at its opposite or southern end as Chodscheli-modschuk.\*

Upon an examination of this catalogue of names, two peculiarities at once strike the observation. Without exception they are compound names, each consisting of two factors, the former of the two being a personal name, the latter indicating some special geographical feature. The only name we have hitherto had which does not begin with a personal prefix is the Toghrak-modschughu, or Poplar Cape, in the Gölme-käti; and setting aside the names of the lakes themselves, this is the only purely descriptive name that occurs here. There are no names like the Sand Cape, the Deep Bay, the Kamisch Cape, the Sheltered Shore, Windy Cape, and similar descriptive and definitive appellations, such as certainly would have occurred had the lakes been old, and their geographical characteristics permanent. The existing nomenclature is indicative of something ephemeral, transient, accidental. The only descriptive epithets are the three suffixes which are so frequently repeated, *modschuk*, *kakmar*, and *bolto*; but the personal names conjoined with them have much the character of an index to a book, being a temporary method of distinguishing the several parts of the lake in which so and so possesses the fishing-rights, or has once made a passing settlement, or has built a hut, or dug a canal. Nor, after the explanations which I have given above, is anything else to be expected. The lakes are of quite recent origin, and the only value they possess for the native population is the fish they contain; consequently the only spots which require to be named are their fishing-stations and places of temporary residence. In all probability these names will persist until the changes now going on in the lake blot out bays, capes, and sounds alike. Most of the men whose names are perpetuated on the shores of the Ullugh-köl are already dead, but their names are still retained, although they have now ceased to subserve their original purpose of a species of register or index of ownership. For instance the fishing at Abdu Semet-kakmasi is now perhaps owned by a Muhamed Achun.

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\* *Modschuk* and *modschughu* are merely two different forms of the same word. Sometimes the genitive suffix is added to the personal name, sometimes not; for instance Murab and Murabne (= Murabning), Semet and Semeti. Instead of following a consistent rule, I have thought it better to reproduce the names precisely as they are pronounced locally on the spot.

Nevertheless certain names occur so frequently that I am inclined to suspect that they are merely parallelisms or analogues. For instance, I noted that homologous capes in the Gölme-käti and the Karaunelik-köl, situated immediately south-east of the canal embouchure in each case, are called Tokta Niasne-modschughu. In the Ullugh-köl however the cape which bears this name lies farther south. And in both the Karaunelik-köl and the Ullugh-köl there is a bay on the east side which is connected with a »wind-saddle», or gateway for the wind, in the dune-crest; this bay is called in both cases Kaghune-kakmasi, another instance of the same name being employed to express geographical homologues. The name Ilias Murab occurs three times in the Ullugh-köl and once in the Karaunelik-köl. At the south-east of the Gölme-käti there is an Abdu Semeti-modschughu, and in the same quarter of the Ullugh-köl an Abdu Semet-kakmasi, that is to say, the same name for a bay and a cape occupying the same relative position in two different lakes. Chodscheli's name is used twice in the Ullugh-köl, twice in the Gölme-käti, and once in the Karaunelik-köl. Of course it is quite possible that all these names, thus frequently repeated, really are the names of especially enterprising fishermen; but it is little likely that one and the same Chodscheli actually owned fishing-rights in three different lakes, when we call to mind the fact that one or in some cases two villages stood beside the feeding-canal of each. It is more likely that once a name has been applied to a characteristic feature in one lake, it is afterwards, by analogy, transferred to a corresponding feature in another lake.

The accompanying sketch-map (Pl. 45) shows the sounding-lines which we ran across the Ullugh-köl. Here again our work was seriously hampered by the wind, so that we were frequently obliged to think more of our own personal safety than of taking soundings. Strictly speaking therefore, the soundings which we took here are not sufficient in number for a completely adequate result; but even though the isobathic lines which the sketch exhibits are therefore only approximate, still they will afford a fairly sufficient idea of the general shape and character of the lake-bottom. The general bathymetrical laws which obtain in all these lakes are, in the case of the Ullugh-köl, in no wise impaired by the presence of the island in the middle; on the contrary, if anything it helps to accentuate them. Thus we always find the deepest places along the foot of the leeward faces of the dunes: the maximum altitudes of the sand-swellings and the maximum depths of the lake are situated in immediate proximity the one to the other. The greatest depth is found, as usual, in the southern half of the lake; the northern half is shallower; and the extreme north end, where the canal enters, is remarkably shallow: the 2 m. isobath runs a long way out from the shore, and the depth over more than 50 per cent. of the area of this northern half does not exceed 4 m. Everywhere where the shores are exposed to the wind, that is to say, the western shore of the lake and the eastern side of the island, the isobaths run at a relatively great distance out, whereas they hug close the eastern side of the lake and the western shore of the island. Accordingly we obtained our five deepest soundings at the foot of the steep leeward flank of the dune-accumulation. Three of these were close to the east shore, namely 8.98 m. in the northern half of the lake, 10.6 m. in the southern half, and 7.40 m. in the eastern bay at the southern end. Near the east side of the western bay we obtained a depth

of 9.17 m., and exactly the same sounding was got near the west shore of the island. From these measurements I am disposed to believe that the drift-sand which comes from the culminating-crest of the dune-accumulation is not carried out into the lake by the wind, but remains on its slopes, and that its equable descent is due to the gravitation of the sand. Otherwise it is just those parts of a lake nearest to the base of the leeward face which in time ought to shoal up. On the other hand, it might be objected that for the maximum depth 10 m. is not such a very great sounding, and also that there is nothing to prove that in reality such a shoaling does not exist. But, as against this, we have only to go to the bajirs of the desert, where the relations can be studied with perfect distinctness; there the foot of the steep leeward flank is sharply differentiated from the intermingled dust and clay of the substratum. There too we find the bare soil between two dune-accumulations, which proves that the drift-sand is unable to blow across from the one crest to the other.

The bathymetrical map shows distinctly, that the lake is divided into two basins, its northern parts running together and forming one basin. Hence the deep trench along the western shore of the peninsula and of the island, which, as I have already said, form a truncated or abruptly terminated dune-length. Unfortunately I was prevented by want of time and the strong wind from running a bathymetrical line between the island and the peninsula; but it may be assumed as pretty certain, that the lake is there relatively shallow, and the supposition is borne out by the soundings taken in the vicinity of the peninsula. The *atscha* or mouth of the canal\* which carries water from the river into the lake had the following dimensions — breadth, 16.92 m.; mean depth, 0.78 m.; maximum depth, 1.40 m.; mean velocity, 0.502 m.; volume, 6.665 cub. m. in the second. These measurements were taken quite close to the river end of the canal, for that was the only spot in which the canal was sufficiently shallow to yield perfectly controllable results. A couple of hundred meters from the lake the depth of the canal was 2.79 m. and its breadth considerably greater, owing to which the velocity was so slow that it was impossible to obtain trustworthy results. This canal, like the canals of the other lakes, traverses ground planted with reeds and free from sand. Thus at the northern end of each of these lakes there opens, as it were, a vast gateway through the dune-wall, so that to paddle off the river into the lakes makes quite a picturesque trip. Propelled by the broad-bladed paddles, and carried along by the current, our canoes glided rapidly along their watery pathway; this latter widened, and then before us opened out the vast expanse of the lake. Indeed when seen through a dust-laden atmosphere, it appears boundless; though when it is clear, the crests of the dunes which shut in the lake all round stand out very distinctly. The steep, towering dune-wall on the east side of the lake is in truth, in its sublime and barren desolation, quite dignified and imposing. Altogether the landscape is quite out of the common.

As the river in the neighbourhood of the canal of the Karaunelik-köl is about the same breadth as the Ullugh-köl, the latter receives water from the river for a considerably longer period of the year than the former does, because the depth

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\* Altogether there are three canals connecting the lake with the river, though at the time of our visit only one of them contained a current.

over the lowest transverse ridge in the bottom of the canal of the Ullugh-köl is nearly twice as great as that over the shallowest transverse ridge in the canal of the Karaunelik-köl. If to this we add, that at both places the river-bed is precisely similar and the difference cannot in any case be great, then we find that, reckoning from the 20th May, the inflow into the Karaunelik-köl ceased when the river had dropped 0.77 m., whereas it had to drop yet 0.63 m. further before it ceased to enter the Ullugh-köl, and this lake consequently became cut off from it. Nor need this difference occasion any surprise, it is only what might be expected. The larger the lake-basin the greater the quantity of water required to fill it, and the greater the quantity of water which flows through the canal, and the longer the period of its flow, the more active and the more effectual is the erosion. We may therefore, with a fair degree of confidence, lay down the following law, that the greater the lake the more deeply trenched is its canal. And in the case of the small lakes, we have also found that the feeding-canals are very unimportant and soon dry up.

The Ullugh-köl has the following dimensions: — the maximum length runs to 7.35 km.; the maximum breadth to 3.2 km.; the eastern sound is 500 m. across; the western 900 m., the island is barely one kilometer in diameter. The eastern bay at the southern end is 2 km. long, the western 800 m. The area of the lake is 14,860,000 square m., or close upon 15 square kilometers; deducting from this the area of the island, 730,000 square meters, there remains for the lake surface 14,130,000 square m. The mean depth, calculated from 46 soundings, is 4.92 m., giving for this lake a mean 0.69 m. shallower than the Karaunelik-köl; but the maximum depth of Ullugh-köl is 0.60 m. greater. Thus the volume of the Ullugh-köl amounts to 69,519,000 cub. m., that is on the 21st May. At the period of high flood the lake level had been 1.345 m. higher than at the date of our visit; this gives an additional capacity of 19,000,000 cub. m. At the date quoted the canal carried a volume of 6.665 cub. m. in the second, or 575,856 cubic m. in the 24 hours, a flood which, assuming there were no evaporation and no absorption into the ground, would fill the lake in the space of four months or 121 days. But under the existing conditions of equilibrium it is precisely these two factors which do levy heavy contributions upon the inflow through the canal. Taking the mean depth of the canal as 2.125 m., that is after adding the high-water level, which was distinctly marked as having been 1.345 m. above the then existing surface, then the breadth is also the same or a trifle greater, the velocity one meter in the second, and the volume about 35 cub. m. in the second. If, then, the lake-basin were empty, it would, on the basis of these data, be filled in 23 days; and if we allow 6.665 cub. m. for the evaporation and absorption, the time required would be 29 days. In point of fact, a large body of water does of course remain in the lake; at the moment when it is cut off from the river, it still contains 49,700,000 cub. m. If now the evaporation and absorption were to go on uninterruptedly at the rate of 6.665 cub. m. in the second, the lake would dry up in 86 days. But here again, as in the case of the Karaunelik-köl, the rate decreases in consequence of the diminishing area and the increasing thickness of the impermeable sedimentary layer which is deposited on the lake-bottom, and also in consequence of the growing, though imperceptible, salinity of the water.



One would naturally suppose that the volumes of the two canals would bear the same proportions to one another that the cubic capacities of the two lakes do, or that  $6.665:2.3 = 92,000,000:32,818,500$ ; but instead of 92 million cub. m., the Ullugh-köl contains only 69.5 million. The level in the river has not changed, consequently that cannot be the cause of the difference. On the other hand the depth of the Karaunelik-köl is 5.61 m., whereas that of the Ullugh-köl is only 4.92 m., and the shallower the lake the greater in proportion to the volume is the evaporation. Let us assume therefore, for the sake of comparison, that the Ullugh-köl also has a mean depth of 5.61 m., then its volume would be only 79.3 million cub. m. That is to say, it would lack 12.7 millions out of the 92 millions which theoretically it ought to possess. The explanation is not far to seek. The water which flows through its canal has to supply not only the Ullugh-köl, but also the Tajiri-kakmasi, the two lakes being connected by a small channel. Entering this channel from the Ullugh-köl, you find it runs to the north, describing several large windings, then to the north-west, and so enters the neighbouring lake. This last, as seen from the top of the dune, appears to be very small, and is separated from its two bajirs by narrow necks of sand, that is Ilias-bajiri and the other bajir described above. The canal is narrow and shallow, and the water in it was stationary, though by very close observation we were able to detect a scarce perceptible movement of the surface, now in the one direction, now in the other; this was caused by the changing gusts of wind. We may therefore consider, that the two lakes lie at virtually the same level. Anyhow they are intimately connected: in fact they are twin-lakes, fed by one and the same canal, for although the Tajiri-kakmasi does possess its own canal connecting it with the river, this has been long dry. During the season of high flood however the little lake is filled from two directions at once; and as long as the Ullugh-köl receives water from the river, and as long as the connecting canal between the two lakes allows it to do so, the water continues to enter the Tajiri-kakmasi. It is to this that the copious supply of water in the two bajirs is due. The 12.7 million cub. m. which the Ullugh-köl lacks, but ought to possess, must be ascribed therefore to the Tajiri-kakmasi. In point of actual fact its content is probably less than this, because a good deal of its water filters away through the sand into its two bajirs. That the lake is small is indicated by its very name, which means Tajir's Bay; that is it does not attain to the dignity of being called by the ordinary name of köL = »lake».

At noon the temperature of the surface water of the Ullugh-köl was  $19^{\circ}.5$  to  $19^{\circ}.8$  C.

I need hardly observe that the hydrographical data which I have quoted above are not to be taken as holding good at all times. That the Ullugh-köl was draining 6.665 cub. m. of water in the second away from the Tarim on the 21st May was a purely fortuitous circumstance; it does not imply that the contribution is the same all the year round, or even that this amount of inflow persists for any length of time. As an actual fact, it varies from day to day, and scarcely remains constant even for a single day at once. A rise in the level of the river augments the inflow into the lake; but a drop of a few cm. suffices to check it altogether, at all events for some hours, or it might be a whole 24 hours, or even causes it to

turn back, for, as the canal itself is only a few hundred metres long, its fall cannot exceed two or three cm. When I paddled across the mouth of the canal of the Ullugh-köl on the morning of the 8th May there was a scarce perceptible movement out of the lake back into the river. Judging by the eye, I put its volume down at 1, or at the most  $1\frac{1}{2}$ , cub. m. in the second. On returning to our winter-quarters at Jangi-köl on the evening of the same day, we fixed, as I have already stated, a sounding-rod, marking  $\pm 0$  at the surface-level. By the 16th May the river had dropped 15.1 cm.; on the 19th it stood only 7.9 cm. below the  $\pm 0$  mark. The next day it rose 1.1 cm., and on the day following that 8.7 cm., so that on the 21st May its level was 2 cm.\* higher than on the 8th May. Slight though this difference of level is in itself, it was nevertheless sufficient not only to neutralise the outflow from the lake, but also to pour into it a volume of 6.665 cub. m. in the second. On the basis of these figures it is fair to infer, that on the 16th May, when the river-level was higher than on the 8th May, a considerable volume of water flowed out of the lake. The Ullugh-köl is subject to oscillations of level for a considerably longer period than the Karaunelik-köl, because its canal is nearly twice as deep as the canal of the latter. The final result is no doubt pretty nearly that which I have already obtained, for during the whole of the time that the river is oscillating in level, now rising, now falling, the surface of the lake is steadily diminishing, in consequence of the evaporation and absorption into the ground, irrespective of what its absolute level may be. The energy of the river is directed to equalising the levels of itself and the lake. After a sudden rise in the river, which, as we have seen, can amount to 1.345 m. above the level of 21st May, the lake becomes filled with immense masses of water boiling like a cataract. Eventually a state of equilibrium is reached, and then water is drawn out of the river by the aspiration of the lake, set up by evaporation and absorption. If the Tarim then drops, the lake drops with it, because it not only suffers loss through the two ways just mentioned, but its water begins to flow out also into the Tarim. According to the natives, the current from the lake back into the river is never very lively; it is never under any circumstances comparable with the inflowing current, so that these lakes may at all times be regarded as parasites living upon the river.

I have already stated that on 7th May the river at the neighbouring Kirtschin carried a volume of 89.06 cub. m., and on the 23rd May a volume of 78.58 cub. m. One would naturally expect therefore, that the inflow into the lake would be considerably greater on the former than on the latter date, when the volume of the river was  $11\frac{1}{2}$  cub. m. less. But it was not so; and for this there exists an obvious and very natural cause, namely the 7th May is the nearer date to the 15th March, when the river at that spot attains its maximum. From and after this date enormous quantities of water flow into the lake; and even though the river continues to drop, however slowly, the inflow nevertheless still goes on, although at a rate which

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\* This figure is only approximate, because the two data last quoted were obtained at a different place from the others, and the resultant 2 cm. is correct only on the assumption that the river possessed precisely the same breadth in both places. But the breadth was undoubtedly greater at the place where the two last measurements were taken, so that the resultant rise, measured on the sounding-rod at Jangi-köl, is more than 2 cm.

decreases proportionally with the subsidence of the river. Thus a flow of 35 cub. m. in the second, the volume we obtained on the basis of a maximum rise of 1.345 m., will not actually fill the lake in 23 days, but it will take a longer time. Still it does fill the lake eventually, and that is the essential thing. On 7th and 8th May the lake was full to the brim, and its level coincided with the level of the river, so that it was easily able to spare a portion of its water when the river did begin to drop. As the river continued to subside, so did the outflowing stream increase in volume. But it is in the first half of May that the summer heat begins to make itself felt; coincidently with this the evaporation increases and the attraction of the lake grows greater. On 21st May the level of the lake was very much lower than on 7th May, and consequently the relative height and volume of the river ceased to be the determining factor, this rôle being assumed by the level of the lake. By the 16th May, when the river had dropped 15.1 cm., the volume had diminished to 66.03 m., and when it afterwards began to rise, the volume augmented to 78.58 cub. m. and the lake again recovered what it had lost to the river — that is, disregarding its loss in other ways.

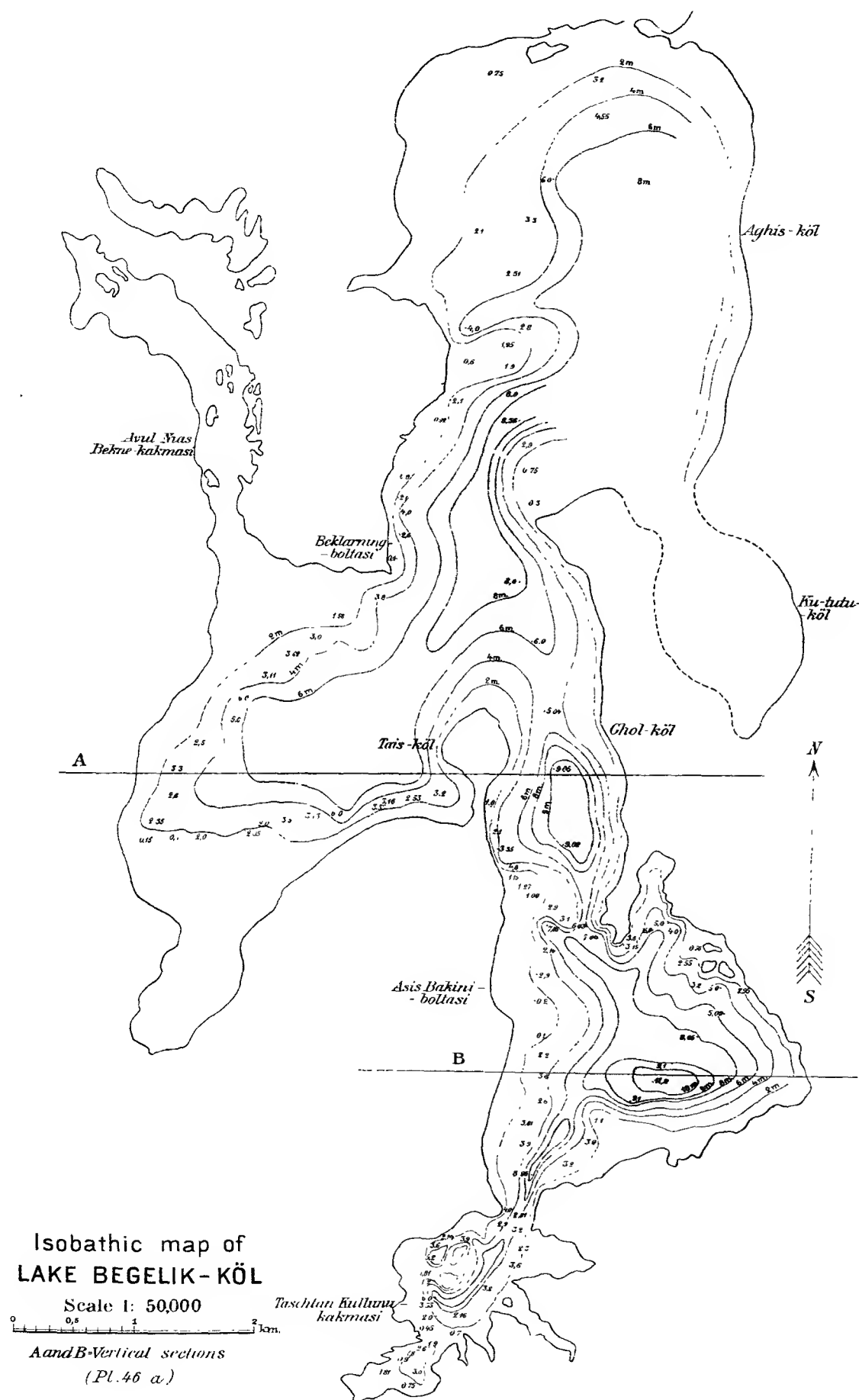
For a thorough and exhaustive description of the hydrographic relations of this region one would need to take continuous measurements in all the lakes over a period of a full year. But as this opportunity was denied me, I have to content myself with such data and material as I was able to gather during the course of a few days' visit. For their own sakes alone these small temporary sheets of water are not worth the expenditure of much time; but their relations to the river, as well as others of their properties, possess great interest, as illustrating and throwing much light upon the problem of the Kara-koschun.

South-east of the Ullugh-köl stretches a series of lakes which I did not visit, all more or less embedded in the sand. The smaller of these lakes, which have been recently formed by the river, or at any rate traversed by it, belong to a different type from those we have been discussing, and are described along with the river. The nearest neighbour of the desert type which the Ullugh-köl has is the Bajir-köl, a long, narrow lake divided into several basins. The next, the Kum-köl, is rather small, and is described as being of a more circular shape. Then comes the Torpak-öldi. The Jalang-dschajir is bordered by sand on the south only; on the 7th May water entered it from the river by an upper canal, but left it again by a lower canal called Süsük-kok-alasi, or the Clear-water Arm. The next lake in the series is also called the Bajir-köl, and is said to consist of four separate basins, of which the three upper ones bear the names of Lakuluk-köl, Dschan Nias-köl, and Muhamed Aru-köl. The tiny lake of Muhamedne-köli is not embedded in sand. After that follow the Gölme-käti (no. 2), Tschapghan-köl, Karaune-tokkan-köl, Talashti-köl, Boba-uktusu, Baschtage-köl, Laj-baskan, Begelik-köl, Ojman-köl (though this belongs rather to the river and is described in connection with it), and the Kök-köl.

On 25th May I made an excursion by canoe to the lake of Begelik-köl. The way to it lay across the Jäkänlik-köl and Talei Kullune-köli, after which we dragged our canoes across an isthmus 110 m. wide and launched them again on the Katik-arik, which issues last from the small lake of Uktusu, but starts from a point midway up the Talashti-köl. On the isthmus in question we found two huts, inhabited

by three families of in all 15 persons. The Katik-arik is in reality an old bed of the Tarim, and at the time of our visit was pretty full, although the current was so slow that it was hardly noticeable, and consequently the water was perfectly clear. It was evident that this bed had only quite recently been discarded by the river. The characteristic alluvial deposits and erosion banks were as distinctly marked and as sharp-cut as any part of the river in which its activity is most pronounced. Then we came to a point where the old bed of the Tarim wheels away to the north and is quite dry, while the Katik-arik, which has hitherto flowed along the old bed, turns off to the south in numerous winding loops. At its very first loop it divides into two arms, of which the one on the left goes to Toktaghono-mandscharlighi on the old Tarim, and then enters the Ojman-köl, whilst the one on the right continues on to the Begelik-köl. Where the latter contracts, its current was pretty lively, but in the open reaches there was scarce any current at all. In one of these the depth was 5.50 m.; the other soundings that we obtained were 3.50, 2.50, 3.95, 4.10, 3.30, and 4.0 m. Thus the canal is tolerably deep throughout; in one place only did we find a very shallow ledge with a lively current. Just above a district called Usunkara-tschilan the Katik-arik (the Hard Canal) is joined by another branch-canal known as the Tschong-aghis, or the Big Mouth. It was at that time dry, except for a little stagnant water at its end. The expansion of the canal bearing the name of Gölme-kadaghan is encircled by reed thickets, tall tamarisks, and poplars, growing on sandy soil. These, although young, are tolerably vigorous, but neither so dense nor so decayed as those alongside the old river-bed. Close to the right bank is a ridge of sand. Small bays or coves, surrounded by reeds and suitable for fishing, are called here also *köürük* or *köjuk*. Another expansion is known as Kosch-arukde-boldschemasi. Then come the district of Istam Begi-kadasi and a second Gölme-kadaghan. Immediately below this last there are yet other huts on the left side of the stream; these are said to have been inhabited by the people of Tikenlik before they migrated to their existing quarters. My guide, Kirghuj, had been one of them; hence his minute acquaintance with the geography of that region. Most of the people removed from this site 20 or 30 years ago, though some lingered on until 16 years back. Crossing yet one more expansion, and traversing a narrow *aghis*, we emerged upon the first basin of the lake, Aghis-köl. Beside this section of the canal and its last expansion there is forest of young poplars, luxuriant though dead. Most of the trees stand in the water, and more or less deeply; they are grey and withered, and nothing but the stems and the larger branches are left. Probably this forest, which is thin and of no account, flourished at a time when the supply of water was not so plentiful. Then from some cause or other the inflow into the lake was stopped, and the locality dried up completely and the poplars withered; but the water having returned, they are now drowned. Amongst the branches that remain were several nests of the *karaune*, a species of very large black waterfowl.

The lake, as we paddled out upon it, lay as still and bright as a mirror; there was not a breath to crumple its surface, and the outlines of the dunes were etched upon it with remarkable vividness. Then, threading a contraction of the lake, Beglarning-boltasi, we issued upon the middle basin known as Ghol-köl, which we crossed to-





wards the south-south-east. This is separated from the third basin, the Tuvadake-köl, by the Bakini-boltasi. At the south end of this basin there is a large bay, with ragged shores, called Taschtan Kullune-kakmasi. From the shore of this extreme outlier we saw in the direction S. 40° W. low, flat sand with two or three small beds of kamisch, and beyond that again at some distance high dunes, pointing to the presence of a bajir. On the whole the sand in this locality does not seem to be as high as beside the other desert lakes. In the bay at the south end of the third basin there are a few islets overgrown with reeds, and the reeds grow also, thinly, on the lake-shore. On our way back we made first for the east side of the Tuvadake-köl, then crossed that basin to its west side, where, with the view of saving time, we dragged our canoes over a tongue of low sand, at the narrowest part of a peninsula. In the middle of the isthmus there was a deep pool, filling the bottom of a hollow in the sand. Then we launched on the basin of Tais-köl, quite a large sheet of water, which again has a bay at its south end. Passing on the left the deep bay of Avul Nias Bekni-kakmasi, we landed on the blunt-ended peninsula, planted with tamarisks, which forms its eastern border. This »four-winged» lake is in general poorer in vegetation than the other lakes we visited: the poplars are few in number, so too are the tamarisks, and where reeds occur they are scanty and ill-thriven. On the other hand the Begelik-köl is well-stocked with fish; we saw antelopes, roe-deer, and hares, and twenty-six years before my guide, Kirghuj Pavan, had shot here a wild camel, as it was wandering along the shore; by its track, it seemed to have come from the south-west. Whether and to what extent the wild camel frequents that desert the native inhabitants were unable to tell me, but they thought it did not come there. At all events the fauna was richer and the flora poorer than beside the other lakes, both circumstances probably the result of the lake's great distance from the river. Whereas the vegetation has been less successful in establishing itself there, the wild animals are less disturbed owing to the distance from human habitations; besides the people prefer fishing in the Talei Kullune-köli and the Jäkänlik-köl. From the top of the dune on the peninsula we obtained a commanding view of the bay of Nias Bek, and of the detached lagoons which lie amongst the sand to the north of it. To the west, on the far side of the next sandy isthmus, lies the Baschtage-köl, its northern parts smothered in vegetation, while to the south-west it is bare of such, and divides into two bays in the same way as the Begelik-köl. Beyond yet another sandy ridge we saw the Talaschti-köl, which is said to be quite as long as the Begelik-köl, but on the other hand is exceedingly narrow (*tar jilgha* = »narrow valley«).

The day was oppressively hot: the water in the middle of the lake had a temperature of 22.° C., and the sand was painfully hot, even through thick-soled boots. In fact I was amazed that the natives, who went barefoot, did not burn their feet. All the morning and until past noon it was perfectly still, but in the afternoon a gentle breeze sprang up from the south-west. And later on in the day I had another opportunity of witnessing one of those characteristic and violent storms which are the most powerful factor in altering the distribution of both sand and water in that part of the world. Up above the dune-summits in the east rose black trumpet-shaped columns. With amazing swiftness they increased both in size and in number.

At first the approaching harbingers of the tempest hung down like a curtain, with a serrated edge at the top, while the sky was streaked with black bands; but soon they all melted together into one opaque mass. The darkening of the sky in this awe-inspiring way is caused by the fine dust; it is this which gives to such a tempest its distinguishing name of *kara-buran*, or »black storm». The cloud of dust must rise to a considerable height above the surface of the earth, for the interval which elapsed between the moment when we first saw it to the moment when it struck the lake was only 20 minutes. During this time it travelled a distance of fully 36 km., at a speed of at least 30 meters in the second. During this period the lake was again as calm as a mill-pond, its surface like a mirror, but a grim gloom was gathering in the background. There is an ominous stillness in the air, an oppressive silence everywhere, even the mirk on-coming tempest, which is rapidly approaching,

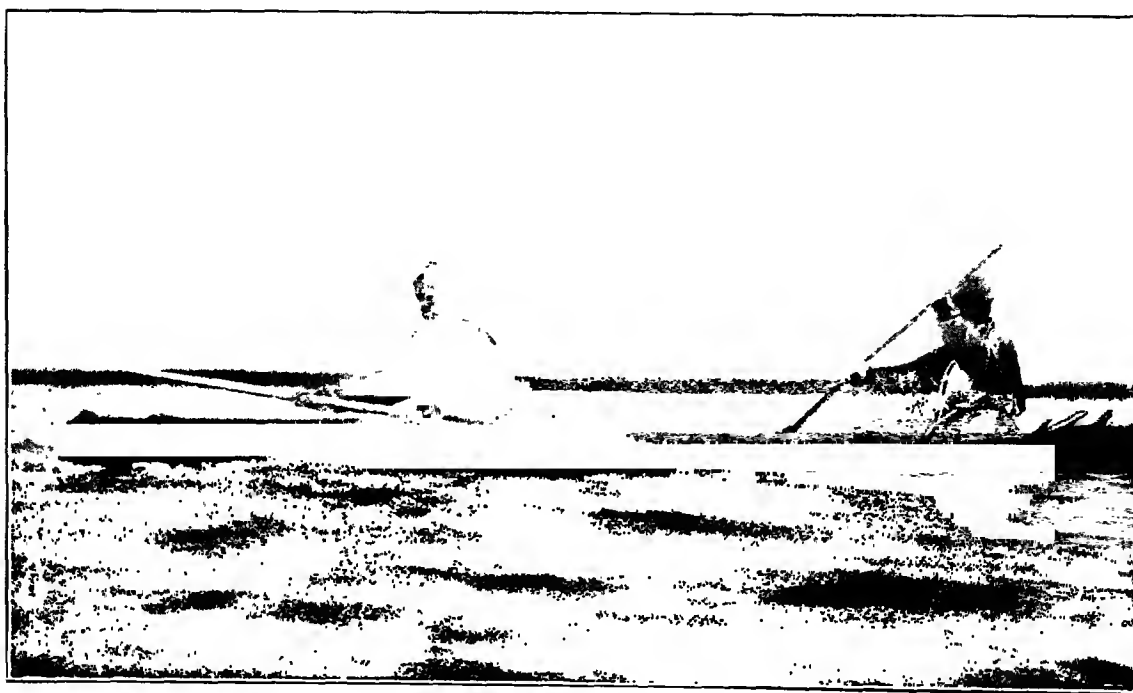


Fig. 252. A CANOE ON THE BEGELIK-KÖL.

does not as yet emit a sound. It strikes the outermost crests of the dunes which fence in the lake on the east. Up whirl clouds of tawny drift-sand, contrasting glaringly against the inky-black mass of dust behind them. In a moment the dunes are swallowed up from end to end. Then comes the swish of the tempest as it swoops down upon the lake. Instantly its surface is whipped into foam, and within a few short minutes the waves are racing across it in a panic of mad terror, and we hear the roar of them as they dash themselves against the western shore. We ourselves are swallowed up in the impenetrable gloom. All we can see is a tiny speck of the lake in our immediate vicinity; our eyes will barely reach to the other canoe. The howling of the tempest is deafening.

This storm continued all the rest of that day, all night, and the greater part of the next day. We only escaped disaster by sheer good luck; but to experience



a storm like that, to be out exposed to its unmitigated fury, and to witness its effects with one's own eyes is worth a little risk. Anybody who visits that region would, without ever having seen one of these storms, say at once, without hesitation, that the dunes he sees could only have been piled up in the way they are by the wind, blowing repeatedly and with unparalleled violence from the east; but it is only after witnessing a kara-buran, and personally experiencing what it is like, that one obtains a clear conception of the relief of the surface, and of the processes which lead to it. Incredible masses of finely comminuted dust are carried on the wings of the wind far across the plains of Turkestan, nor are they dropped until the atmosphere becomes perfectly still again, and even then it is generally a couple of days before the air thoroughly clears. The sand however does not accompany the dust; you both see and feel that it remains behind. You see the compact masses of yellow sand which the storm has whirled aloft speedily dissolving again on the leeward side of the dunes; they fade away and disappear in the dark-grey haze, which the tempest trails behind it. You feel also that the atmosphere cannot be charged with sand, for if it were so, you would feel, as you do feel when you walk over the dunes in a storm, the incessant stinging of its myriads of particles as they strike you forcibly in the face. From the fine dust you do not on the other hand experience so much as the faintest tickling of the skin; in fact, you are unable to *feel* it at all. The only inconvenience it is to you is that your throat soon turns dry, and the inner corners of your eyes get filled.

The impression which such a tempest forces home upon you is, what an enormous deflation or power of transportation the wind must possess in a region such as this! All the fine dust which is produced through weathering and other agencies in the mountains of Central Asia, greatly disintegrated as they already are, all the dust which is produced by the friction of the particles of sand, grinding one against the other, and all that which originates from the mud deposited in the lakes which subsequently dry up — it is all borne westwards by these storms. Assuming that, during the stormy season, there is one black tempest a week, then each such storm carries away all the products of disintegration which have been accumulating throughout the preceding week and transports it a long way towards the west. After the cessation of one of these tempests it is quite noticeable how »clean swept» the surface appears; but it does not wear that appearance long, for the dust which is hovering in the air soon begins to settle again. At the end of a few days' calm, after a storm of this character, a layer of dust is deposited upon the sand, causing one's footsteps to stand out in lighter colouring. I did not attempt to measure the quantity of dust which one of these tempests is capable of carrying away with it, and indeed any such attempt would be attended with considerable difficulties. But on the assumption that every cubic meter of the dust-laden atmosphere deposits a layer  $\frac{1}{100}$  mm. thick, or in other words  $\frac{1}{100000}$  of its own volume, the total amount is soon seen to run up to altogether fabulous and unmanageable figures. If we assume an ordinary storm to travel at the mean velocity of 30 m. in the second — and I *have* measured 27 m. at the surface of the earth — also that the dust-bearing strata of the atmosphere have a depth of 200 meters, and further that these strata stretch right across the entire Lop region, a distance of 200 kilometers, then in the space

of 10 minutes only we obtain a volume of 7,200,000 cub. m. of drift-dust, or if the storm continues 24 hours, a volume of 1036 million cubic meters, equivalent to a loess deposit over the whole of East Turkestan of between 2 and 3 mm. in thickness; or the same number of centimeters if we assume that ten to twelve such severe tempests blow in the year. In the course of a century this would be equal to an elevation of the surface to the extent of from 2 to 3 meters. In several parts of the country, where the ground is free from sand, or barren, or sheltered from the wind, as in the bajirs and in certain parts of the Lop Desert, the traveller is often in danger of being buried in the loose dust; and in the desert just named he always prefers any surface to the dust-choked depressions to travel on. That similar deposits of loess never succeed in forming in exposed situations is quite self-evident. The dust which is dropped by one storm is carried on farther by the next. In a word, it is in never-resting circulation, giving rise to the desert haze or dust-gloom which is so characteristic of East Turkestan; it is for this reason that you are seldom able to distinguish the mountains which girdle it round, even from a comparatively short distance away. The dust which falls on the windward side of the dunes is blown away, that which falls on the leeward side has every prospect of lying there, at any rate in part, and of being covered by the down-flowing sand; nor will it come to light again until after the dune-mass has taken a full step in advance, when after its century-long rest it once more begins its peregrinations. If the ground is moist, the dust which falls into the bajirs remains in great part where it falls; otherwise it is whirled up again by the north-east and south-west winds. The dust which falls among the belts of vegetation is retained by the roots, and so becomes an essentially contributing factor to the circumstance noted by Przhevalskij, that the lower Tarim flows as it were between ramparts, and that at a higher level than the adjacent country on either side. Finally, the dust which falls directly into the river, or which is immediately caught up and carried along by its erosive power, finds a resting-place partly in its marginal lakes, partly on its countless sedimentary deposits, and partly in its terminal reservoir. The larger quantity finds its way into the last-named, that being the goal towards which the entire system is continually moving with concentrated energy. To the deposition of sediment there exists a limit; it is reached when the erosive power of the stream and the power of deposition implicit in its water counterbalance one another. The sediment which is laid down at the season of low water is swept away in the succeeding high-water period; thus during these two seasons it is in a state of intermittent movement, and only comes to rest during the former. Fresh material is continually being brought down from above, but the banks of sediment gravitate on the whole towards the terminus of the river, the Kara-koschun marshes. There it is finally yielded up by the stationary, filtering water and falls to the bottom, and like the dust under the dunes enters upon its century-long rest. Nor will it resume its peregrinations until the distribution of the water undergoes an alteration. However small a particle of dust may be, it can never be destroyed and can never disappear. Its destiny is inexorably knitted to the history of the development of the Tarim basin. So long as it is exposed, it must follow the movements of the atmosphere and the water; when brought to rest, it finds its own special niche under the law of the earth's attraction. But it can never

get out of the basin of the Tarim; the limit of its migrations is the ring of mountains which girdle that basin all round. To their feet it may indeed be carried, it may be over a vast distance, but once it arrives there, there it must remain. The basin of the Tarim is a receptacle which collects and stores up solid material, but never parts with it again. During the millenia of years its surface must be raised and levelled, and in fact it is excessively flat, indeed practically horizontal. While the wind blows the dust westwards, the river, in so far as it gets the dust into its power, carries it back towards the east. When a river, such as the Kerija-darja, is no longer able to reach the main stream, it becomes appreciably shortened by the sedimentary matter which it brings down itself, by depositing it in the desert on a *lajdang* or »silt bed«, which sometimes grows to a considerable size.

All this will help to emphasize the importance which attaches to a desert storm, a *kara-buran*. When the effects which these produce in thousands of years are all added together, it is obvious they must leave perceptible traces behind them. Winds from other quarters than the east, seldom waxing as they do to the power of actual storms, do but arrest and retard a little the final issue of these easterly tempests.

The factors therefore which in this part of Central Asia cooperate in the reformation of the earth's surface, are thus, apart from disintegration, which has its own special field in the encircling ring of mountains, — are thus the wind, the water, sand and dust, the last two being the products of disintegration. The wind carries away the products of disintegration and piles up the drift-sand into what are almost mountain-chains. The water levels down, and has already so far done its work, that the Desert of Lop is almost everywhere horizontal. The sand is disseminated all over the face of the country, smothering the vegetation. The dust, a comminuted and volatile material, hovering between sky and earth, is quite as much a meteorological as a geological element; for while it is the transporting power of the wind which carries it away from the rock out of whose ribs it has been loosened by disintegration, it is none the less a meteorological factor, not so much because it constitutes a peculiar variety of precipitation, as because it produces upon the temperature relations at the surface of the earth the same effects as are produced by a heavily clouded sky. Not only does it check insolation, but it also raises the night temperature, by acting in the same way as a compact veil of clouds which checks radiation. Thus the dust plays a double rôle: in part it contributes directly to the formation of strata, and in part it helps to minimise differences of temperature, and thus to some extent acts as a check upon disintegration.

I need not add, that human agency is likewise a factor which cannot be neglected in an enumeration of the operative causes to which the physical conformation of this part of the world is due. The cultivated area is confined to soil which is composed of æolian matter that provides the agriculturist with a grateful medium to work with, the dust in these oases being bound by vegetation. Through the agency of man the river is deprived of an important part of its volume. But there is one force of nature over against which man is powerless, and that is the drift-sand. He does, it is true, do his utmost locally to check its advance; but he is soon discomfited, and abandoning his fields has to betake himself to safer regions. Nothing proves this more plainly than the ruins which I discovered in the Kerija Desert in 1896.

The storm has carried us too far away from our lake; let us therefore return to the Begelik-köl. I thought it however worth while to dwell a little upon this natural revolution which plays such a characteristic and important rôle in this part of Asia. But no description can give an adequate conception of the reality; it is absolutely imperative to have actual experience of such a storm to understand its power and its effects. It spreads itself like a pall over the earth, and is not without its awe-inspiring influence upon the mind. For my own part, I welcomed these storms, not only for the instruction they afforded me, but also for the coolness they brought, and not less for the day's relief they secured us from the clouds of gadflies, gnats, and mosquitoes, which at this season of the year make a visit in the Lop country a veritable purgatory.

Let us now look at the results obtained from the trip across the Begelik-köl, which I have described above. As usually happened, I was forced by the storm to discontinue my soundings; consequently my data are not sufficient for this lake either, and the only claim I can make for the map I offer is that it is a reconnaissance, and is only sufficient to give an approximate idea of the topography and bathymetrical relations of the lake. Accepting the nomenclature of the natives, we find that the lake is divided into seven basins, all however intimately connected one with the other. If however we look at them in the light of the maximum depth, they shrink to five, all situated on a gently curved **S** extending from north to south. The largest lake is the Aghis-köl, or the »Mouth Lake», situated farthest to the north; it was here that we were most unfortunate in our soundings. This lake is connected with the last expansion of the feeding-canal by a narrow watery passage, led between two piers, through which a gentle current was running into the lake. The Ku-tuttu = Where the Swan was Caught, is regarded by the natives as an independent lake, though connected with the Begelik-köl, and supplied by it with water. But as seen from our point of vantage on the dune it had rather the appearance of a bay or apophysis of the east shore of the Aghis-köl. Next comes the sound of Beglarni-boltasi, 1230 m. across, between two sandy peninsulas, and south of it lies the Tais-köl, or the Shallow Lake. The name is very appropriate, for this lake does appear to be a couple of meters less deep than the others. It too possesses two bays, probably both very shallow, but only the more northerly one is named. Between the Tais-köl and the Ghol-köl, or the Deep Lake, lies the peninsula already spoken of, an amorphous heap of sand at the end of a narrow stalk. Here is the sound of Asis Bakini-boltasi, 770 m. across, with a similar sandy peninsula on its eastern side. South of this contraction comes the Tuvadake-köl, or the Lake of the Hills, triangular in shape, and giving the greatest depth I sounded, not only in the Begelik-köl, but anywhere in these desert lakes, namely 11 m. When I add that this is one of the three maximum soundings I obtained in all the Lop country right away down to the Karakoschun — 14 m. was the absolutely deepest sounding — some idea may be formed not only of the general shallowness of these lakes, but also of the remarkable and persistent flatness of the country as a whole, and of the absence of even minor undulations. A region such as this can only originate under conditions which presuppose sedimentary deposits to have been first laid down in water, and now to be dropped from the atmosphere above. If its narrow sound were filled with

sand, the southern bay of the Tuvadake-köl would form the first bajir of the Begelik-köl.

Taken as a whole the Begelik-köl is 11.6 km. long, with a maximum breadth of 4.15 km. It is consequently appreciably larger than the lakes I have described above; and it likewise differs from them in its peculiar and fantastic shape. For whereas they are more homogeneous and self-contained, and either elliptical in shape or composed of two basins, or, again, resemble a section of a river-bed, the Begelik-köl is, as it were, plucked asunder, and it is possible that the two bays, the southern bay of Tais-köl and the Ku-tuttu, are both more irregular and penetrate deeper inland than I was able to perceive from the canoe. Otherwise all the characters which we have found to distinguish the desert lakes recur also here. The separate members of the lake are prolonged, if not in the usual north-north-east to south-south-west direction, at all events from north to south. The Ku-tuttu and Avul Nias Bekne-kakmasi are even prolonged from north-west to south-east, and this direction, taking the prevailing winds into account, is a more reasonable one than the usual north-north-east and south-south-west.

Another feature common to the Begelik-köl and its associates is that it too has its greatest depth on its eastern side, under the highest dunes, while it shallows towards its western shore; this is especially true of the Tais-köl. The extreme north of the Aghis-köl is likewise shallow. In this part of the lake the isobathic lines for 2 and 4 m. run a long way out from the shore, whereas on the east side of the lake they come close together under the dunes. The shape of the lake is of course determined by the configuration of the underlying substratum and the arrangement of the dunes. To judge from the contours of the Begelik-köl neither the one nor the other of these determinants is so precise or so distinct as in the case of the other lakes, where it is almost everywhere possible to distinguish two long and stupendous accumulations of dunes, one on each side of the lake. Here too there are indeed accumulations of sand, but they are not so accurately arranged, and are broken and truncated. Even with the naked eye it is easy to perceive that these dunes are not appreciably lower than the dunes beside the lakes we have already considered. Neither is their parallelism so regular: on the east side of the Tuvadake-köl there is a dune running north and south, and another on the west of Nias Bek's bay and the Tais-köl, although in the north it inclines slightly to the north-north-west. On the peninsula east of the Ghol-köl there is a dune which lies distinctly south-south-east and north-north-west. Thus the Begelik-köl lies in a part of the desert in which the sand is not only lower but less regularly cohesive than in other parts; and it is to this circumstance that we must attribute the fact of the greater depth of these lakes. East of the easternmost part of the Tuvadake-köl the conformation of the sand allows comparatively free access to the wind, and there can be no doubt that the particular locality was formerly, at a time when there was no water in the lake-basin, exposed to more energetic wind erosion. As I shall have to discuss the sandy desert and its extent in another part of this present work, I will only say here, that the increasing depth in the lakes as we descend the river is not merely a matter of chance, due to the small number of soundings taken, but it is due to other causes. The maximal depths of the four lakes I measured are as follows: —

Gölme-käti . . . . .	7.0 m.
Karaunelik-köl . . . . .	9.4 »
Ullugh-köl . . . . .	10.0 »
Begelik-köl . . . . .	11.0 »

And since the altitude of the sand decreases *pari passu* in the same direction, the inference forces itself upon one, that as its elevation increases so does the amount of protection it affords against the erosive energy of the wind. Further on we shall see what takes place in those parts of the Desert of Lop in which there is no sand, and where the clay substratum is consequently exposed to the unmitigated violence of the winds from every quarter of the compass. There deflation and corroration combine together to accomplish a gigantic task, a task initiated by the wind, which is, so to speak, a carpenter's plane of colossal dimensions, and works it with a power that nothing can withstand.

On 25th May the dimensions of the Katik-arik were — breadth, 19.4 m.; mean depth, 1.02 m.; mean velocity, 0.144 m.; and volume, 2.85 cub. m. in the second. The branch which leads off to the lake had the following dimensions, breadth, 21.3 m.; mean depth, 0.14 m.; mean velocity, 0.567 m.; and volume, 1.7 cub. m. in the second. The difference of 1.15 cub. m. finds its way therefore into the Toktaghono-mandscharlighi on the old Tarim, and thereafter falls into the Ojman-köl.

In round numbers the Begelik-köl has an area of 30 million square meters, and a mean depth of 3.67 m., this being the mean of 88 soundings; so that the amount of water in it was 110 million cubic meters. Although the maximum depth is greater than in the sister lakes, the mean depth is considerably less, though this result may be to no small degree only apparent, owing to my not being able to complete several series of soundings. At any rate, it is certain that this lake is greater than those we have lately been discussing. The feeding-canal was evidently falling and its volume diminishing. In consequence of the general subsidence in the river, the surface of the Jäkänlik-köl dropped 2 cm. between 9 p. m. on the 24th May and 7 a. m. on the 26th May. On the very shallow threshold where we measured the inflow canal of this lake the maximum depth was 22 cm. Thus a drop of only 22 cm. in the general water-level is sufficient to cut the lake off entirely from the river. The lake was, at the date mentioned, pretty full, and the evaporation and absorption kept tolerably even pace with the subsidence in the little lake of Uktusu, from which the canal last issued. Were this not the case, the big, shallow lake would, in consequence of its evaporation, set up a much stronger »attractional» flow through the canal, in fact the water would pour through it like a cataract.

This lake also differs from its compeers in respect of the structure of its canal; for whereas the canals of the latter seldom exceed  $\frac{1}{2}$  km. in length, the canal of the Begelik-köl, reckoned from the old abandoned river-bed, runs to a length of 6.75 km. After we had passed the shallow threshold at the point where the Toktaghono branch is shed off, the depth increased suddenly to  $3\frac{1}{2}$  and  $5\frac{1}{2}$  m. The southern portion of the canal, which is shut in by dunes, may almost be regarded as a narrow continuation of the lake, which is being gradually encroached upon and choked up by vegetation.

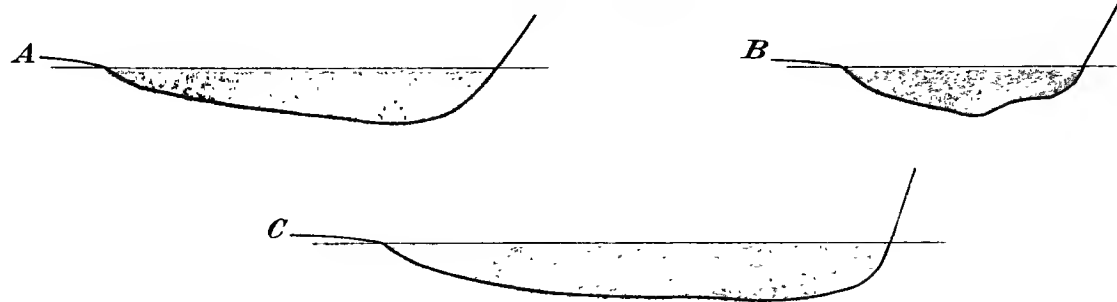
# Vertical sections of Lakes.

(Vide Pl 41, 45 and 46.)

Dr Sven Hedén: Journey in Central Asia 1899-1902.

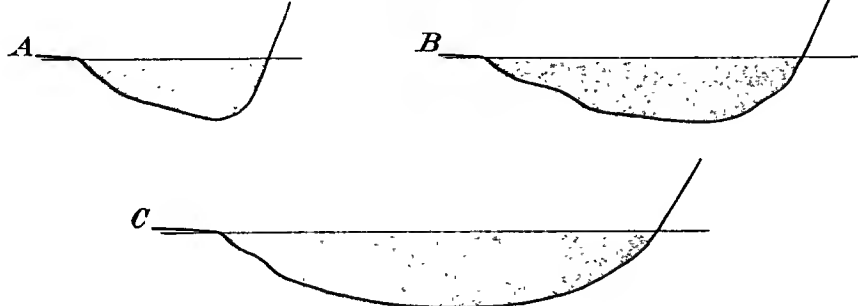
Pl. 46 a.

## Gölme-käti



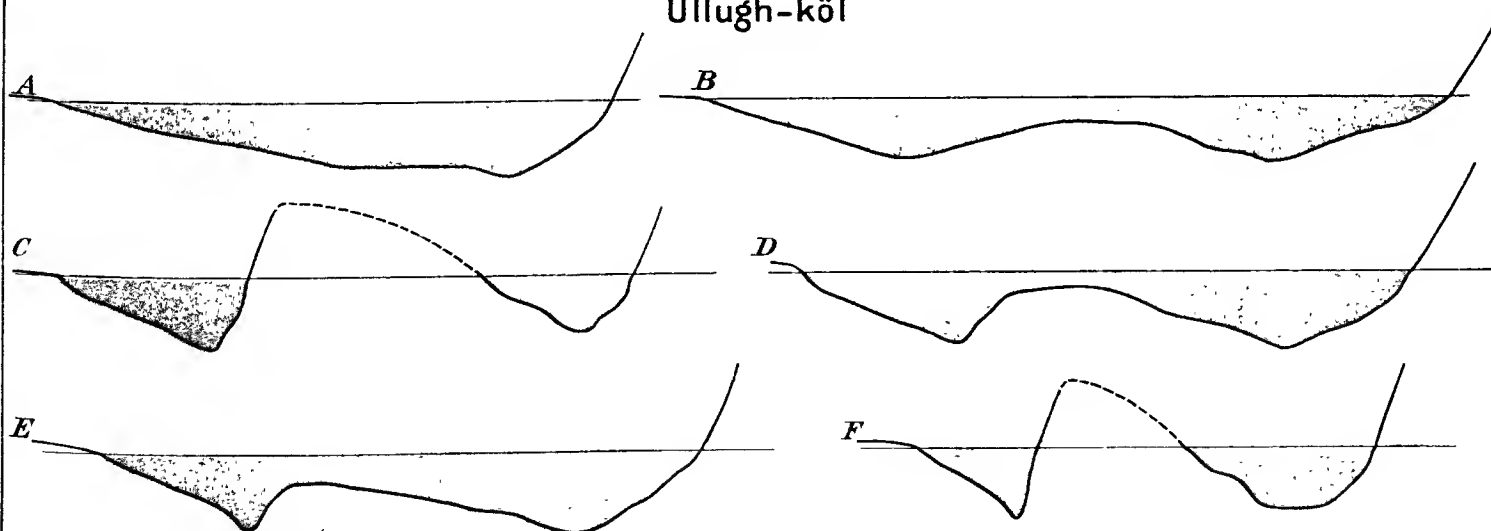
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## Karaunelik-köl



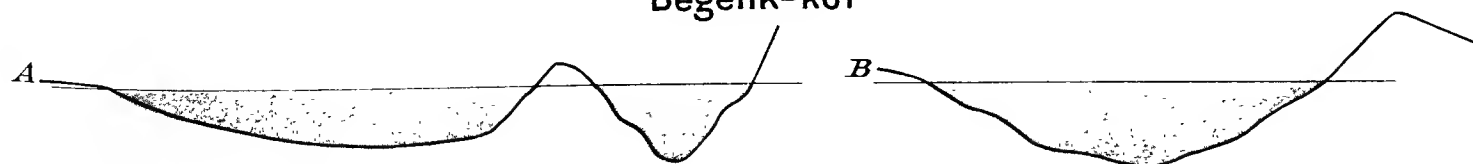
Vertical scale  $\frac{1}{1000}$   
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## Ullugh-köl



Vertical scale  $\frac{1}{1000}$   
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## Begelik-köl



Vertical scale  $\frac{1}{1000}$   
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Just in the locality with which we are now dealing the Tarim has shifted its bed, but this time, contrary to its wont, it has deviated to the left, that is to the east. Beginning at Bulung-su, it runs alongside the sand, and formerly gave origin to the lakes of Gölme-käti (No 2), Tschapghan, Karaune-tokkan, Talaschti, Baschtage, and Begelik. All these lakes are said to be old, and strange to say, the natives of that district aver, that they are natural depressions in the desert, which have been filled by letting in water through canals dug from the right bank of the former river. It is however greatly to be doubted if this was the case, at all events as a general rule. It is more likely that the river, at some period when it carried a bigger volume than it does now, overflowed its banks at the season of high water. But as the river has also for long distances embanked itself between natural ramparts, it is possible that the natives have in places cut these through with the view of procuring for themselves fresh fishing-grounds.

But the river having altered its course, some of these lakes are now cut off from it, and are consequently shrinking and turning salt. Those of them, however, whose canals are sufficiently deep still continue to be augmented from the old river-bed. The canal which furnishes water from the new river to that part of the old river-bed in which we found the Katik-arik is the Talaschti-kok-alasi; both above and below this canal the old river-bed is dry. But as there is a limit to the amount of water contributed by this canal, even in the high-flood period, there is doubtless a period of desiccation in store for most of these lakes, and they are advancing towards it at a rapid pace. Beside both the Baschtage and the Talaschti-köl there were formerly villages, which are now deserted. The water in the last-named is however still so far fresh that it affords profitable fishing. Every now and again it is visited by a fisherman's canoe, the crew of which find occupation for a few days.

The Begelik-köl gets its name from the fact that it afforded the best fishing, and consequently was always let to the beks. Below it there comes yet another chain of desert lakes, about which I possess nothing but oral information. Amongst these are the Kök-köl, or the Blue Lake, and Baschtage-köl (No 2), the breach in the dunes leading to which we saw south-south-west from Ottak-köl. Although neither receives now any fresh inflow, they both contain fresh water. On the 28th May I passed the now dry canal which leads to the lake of Ettek-köl; this too is no longer fed at the high-water season, and consequently has been converted into a concentrated salt *daschi*. And the same fate is also said to have overtaken the Schikak-köl. The next lake in the series is the Ghodsche-tutghutsch-köl, which is also embedded in the sand. It lies a pretty long way from the river, and its feeding-canal is now dry, so that its water is salt. But that it did contain fresh water formerly is evident from its name, which means »Where the Feathers of the Wild-Duck were Gathered». The Kotschkatsch-köl on the other hand does receive water at the season of high flood. On the first of June we passed the last lake in this long chain. It is situated just above Arghan, and bears the name of Baschtage-köl (No 3), but is also known as the Muhamedning-baschtage-köl (the Upper Lake of Muhamed). It is said to be divided into three basins — Aghis-köl, Tughadake-köl, and Tschapghan-köl.

## CHAPTER XIX.

## GENERAL CONCLUSIONS REGARDING THE LAKES.

I have now taken account of all the desert lakes on the right bank of the Tarim, of which I have any knowledge either from my own observation or from oral information supplied by the natives. I do not of course pretend that my list is complete, for it is quite possible that one or other lake may have escaped my observation, or that some which possess no names, or are not used for fishing, were not mentioned to me. But even with those which I have named we have a pretty long series, all situated on the right bank of the Tarim between a point just below Karaul, and Basch-arghan. The fact of my having been able to visit, and more or less imperfectly study, only six of them is of the less consequence, when we call to mind how closely they resemble one another, and that they all alike owe their origin to the same hydrographical circumstances and the same configuration of the substratum. The material I did collect is at all events quite sufficient to allow of the necessary conclusions being drawn with regard to their formation, and the part they play in the physical geography of the region.

Recapitulating what I have said above, I will first give the names of the lakes in order. They are:

Teis-köl . . . . .	or the Shallow Lake.
Tus-alghutsch . . . » »	Lake where Salt is Taken.
Sejt-köl . . . . . » »	Sejt's Lake.
Aghesi-köl . . . . . » »	Aghesi's Lake.
Daschi-köl . . . . . » »	Lake of the Salt Pool.
Tana-baghladi . . . » »	Lake Dammed by Tana.
Talei Kullu-tschapghan » »	Lake Dug by Talei Kullu.
Basch-köl . . . . . » »	Upper Lake.
Uja-köl . . . . . » »	Lake of the Reed-thickets.
Jangi-köl . . . . . » »	New Lake.
Gölme-käti-köl . . . » »	Lake of the Lost Net.
Toghraklik-köl . . . » »	Poplar Lake.
Karaunelik-köl . . . » »	Lake of the Karaune-bird.
Tajiri-kakmasi . . . » »	Tajir's Bay.

Ullugh-köl . . . . .	or the Big Lake.
Bajir-köl . . . . .	» » Bajir Lake.
Kum-köl . . . . .	» » Sand Lake.
Torpak-öldi . . . . .	» » Lake where the Calf Died.
Jallang-dschajir . . . . .	» » Naked Lake.
Bajir-köl (No 2) . . . . .	» » Bajir Lake.
Gölme-käti (No 2) . . . . .	» » Lake of the Lost Net.
Tschapghan-köl . . . . .	» » Dug Lake.
Karaune-tokkan-köl . . . . .	» » Lake where the Karuna-bird Breeds.
Talashti-köl . . . . .	» » Disputed Lake.
Boba-uktusu . . . . .	» » Old Man's Little Lake.
Baschtage-köl . . . . .	» » Upper Lake.
Laj-baskan-köl . . . . .	» » Silt-filled Lake.
Begelik-köl . . . . .	» » Beks' Lake.
Kök-köl . . . . .	» » Blue Lake.
Baschtage-köl (No 2) . . . . .	» » Upper Lake.
Ettek-köl . . . . .	» » Western Lake.
Schikak-köl . . . . .	» » Lake where one Lies in wait (for Fish).
Ghodsche-tutghutsch-köl . . . . .	» » Lake where the Wild-Duck's Feathers are Gathered.
Kotschkatschi-köl . . . . .	» » Kotschkatsch's or the Swallow Lake.
Baschtage-köl (No 3)* . . . . .	» » Upper Lake.

From this it results, that there are no less than 35 lakes embedded in the sand along the right bank of the Tarim. In all probability they really number far more. In the following table I give the names and particulars of those which I either measured topographically, or else sounded, or both: —

Name of Lake.	Length in km	Maximum breadth in m.	Minimum breadth in m.	Mean breadth in m.	Area in sq. meters.	Max. depth in m.	Mean depth in m.	Cubic contents in cub. m.
Basch-köl . . . . .	15.9	2,000	1,000	1,345	21,000,000	—	—	—
Jangi-köl . . . . .	13.35	1,508	965	1,244	15,000,000	—	—	—
Gölme-käti . . . . .	8.0	2,500	1,000	1,662	13,794,000	7.0	—	—
Karaunelik-köl . . . . .	5.2	2,000	300	1,125	5,850,000	9.40	5.61	32,818,500
Ullugh-köl . . . . .	7.35	3,200	—	—	14,860,000	10.0	4.92	69,519,600
Begelik-köl . . . . .	11.6	4,150	—	—	30,000,000	11.0	3.67	110,000,000

If now I may from the materials at my disposal venture to draw any conclusions applicable to the lakes as a whole, I will do so by making a beginning with the column of areas in the table last given. This furnishes a mean area of 16 million square meters for each lake. Let us assume that each of the other twenty-nine lakes possesses the same area, and that their mean depth is 4.73, the average mean depth of the three lakes I did sound. This gives for all these twenty-nine

\* I have omitted from this list the Ettek-bajir, or the Western Depression, and the Kaltschini-bajiri, or Kaltschin's Depression, because they are probably without water.

lakes together an area 464 million square meters, or, including the six already considered, a grand total of 564 million square meters; from which we obtain 2,667,000,000 cub. m. as the cubical capacity of all the thirty-five lakes together, a figure which is too small rather than too large. For, setting aside any lakes that may have escaped my observation, there is this fact to be reckoned with, that one of these at the time of our visit was actually ascertained to have dropped 1.345 m. since the last preceding high-water season. If we imagine all the lakes to be empty, then the river, even when it carried, as it did at Schirge-tschapghan on 19th April, a volume of 101 cub. m. in the second, would require a space of 306 days of 24 hours each to supply them with this 2.6 milliard cub. m. of water; and if it carried, as it did at Jangi-köl on 16th May, a volume of 66 cub. m. in the second, it would require no less than 468 days of 24 hours each to fill all these parasitical basins. These figures furnish some idea of the immense tax which these lakes levy upon the river. In point of fact however they are all more or less constantly filled, and the only losses they sustain are through evaporation and absorption. If we assume, and the assumption is rather under than over the mark, that the quantity which is annually lost in this way amounts to a layer one meter deep over their conjoint area, the total loss from this cause would amount to no less than 564 million cubic meters. And in order to make good the loss thus occasioned, the river would require, assuming its volume to be 66 cub. m. in the second, a space of 99 days in which to empty itself, without deduction, into these depressions. In other words, the Tarim is compelled to yield up one-fourth of the whole of its annual discharge in order to supply these marginal lakes. This is tantamount to saying, that the Kara-koschun is deprived of one-fourth of its volume simply to feed these lakes alone, regardless of the innumerable lakes and lagoons which hang upon the river all along the other parts of its course. The greater the increase in the volume of these desert lakes the greater the loss of the Kara-koschun. At any rate this has unquestionably been the case in the latest stadium of the river's history. The Tarim raises the height of its inclosing ramparts by arresting the dust and binding it together by means of the retentive power of the belts of vegetation which accompany it. The higher these ramparts grow the greater becomes the liability of the river to overflow and inundate the country on both sides, and the greater consequently its tendency to fill all the depressions there situated. For this reason I found that the Kara-koschun is far smaller in size than Prschevalskij states, although only twenty years elapsed between our respective visits. The diminution is also attributable possibly to other factors as well, for instance, a more extensive use of irrigation in East Turkestan. But the river cannot obviously go on for ever building up these containing ramparts, and raising its own bed by laying down sedimentary deposits; on the contrary, it is very quick to respond to alterations of level, and frequently changes its bed. For instance, along the stretch where the Begelik-köl and its sister lakes lie, we have found that the river has shifted to the left, and that the desert lakes beside the old channel are destined gradually to dry up. If, as is not at all unlikely, the river should ever return to the regions on the east through which it formerly flowed, all these lakes that we have been studying would disappear *in toto*. A natural consequence of this would be, that the terminal reservoir of the river-system would begin to expand

again. All these changes and vicissitudes are the inevitable outcome of the circumstances; they cannot well be otherwise, and nobody need be astonished at the extreme instability which governs the hydrographical relations of the country of Lop. Matter is everywhere subject to revolution and recurrence, but it is seldom that its translations and metamorphoses take place so swiftly and in such reliable forms as here. The river preys upon the dunes that lie on the extreme edge of the sandy desert, and the sand it brings down fills its bed and raises it, at the same time that the descending dust raises the height of its containing banks. Both dust and sand travel eastwards with the water after having previously travelled westwards on the wings of the wind. Here a basin is filled with these two materials; its water is poured into some other basin elsewhere. Here a river-bed is obliterated, owing to the waters which have hitherto made their way through it seeking a path in another direction. Everything is in a condition of unceasing movement. The processes of the deposition and augmentation of the masses of sand and dust proceed slowly; but the changes in the direction of the waters take place every year, and by sudden caprices, under our very eyes.

Taking the mean length of the six lakes whose dimensions I ascertained, the strip of country in which all these changes take place measures 180 km. in length and 10 km. in breadth. It has therefore an area of 1,800 million square meters. If now the total area of the lakes equals 564 million square meters, it results that one-third of the entire region is under water. As I have already indicated, there is the still further possibility, that the dunes rest upon subterranean lakes or subterranean parts of the lakes which are actually visible. The remaining two-thirds of the surface consist of dunes of drift-sand, and to some extent of bajirs. And we may probably with confidence apply the same proportions to the adjacent parts of the desert, and say that one-third of it consists of bajirs, the remainder being covered with sand. The two circumstances which essentially render possible the origination of lakes are the pre-existence of the depressions and the river's tendency to provide itself with ramparts and to raise the level of its bed, the consequence of which is that the level of the river at full flood tends to rise higher than the level of the adjacent country (fig. 253).



Fig. 253.

To this it might be replied, »why do not the same conditions prevail on the left bank?» The reason they are not discernible there is, that in its present position the river forms the dividing-line between the steppe and forest country on the one hand and the desert on the other. The entire Mesopotamian tract which extends from this part of the Tarim and the Kongsche-darja produces vegetation, the dunes being both rudimentary and sporadic in their appearance. While the sand-free parts of the desert are entirely exposed to the erosive force of the wind, this natural agent produces no effect upon the region of vegetation. On the contrary the forest arrests its progress; the dust it brings with it is much more likely to be let drop on the leeward side of the forest, and there become quiescent. The kamisch steppe and

the underwoods also help to retain the æolian precipitation, and fix it to the spot. Hence the belt of vegetation lies only a trifling degree higher than the desert; this explains why the Tarim and the Kongsche-darja do not unite before reaching Tikenlik and Arghan. They flow on the opposite sides of a ridge, which is being raised in consequence of the retentive power of the vegetation (fig. 254). As a consequence of this we shall find that those arms of the lower Tarim system which lie on the extreme east have a tendency to flit to the east, and those on the extreme west a tendency to flit to the west. And the same circumstance explains to some extent also the tendency of the Tarim to spread itself out like a delta as it approaches its termination; though the principal cause of this is to be sought elsewhere, and is discussed in another part of this work.

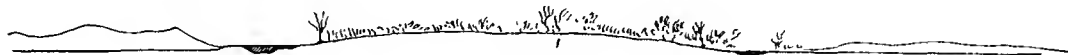


Fig. 254.

The situation of these marginal lakes is easily understood when we bear in mind that the surface material is accumulated on the left bank, but is swept away on the right bank, and when this correlative process goes on century after century, it must inevitably leave an effect behind it upon the course of the river, by deflecting it to the right. The following reasoning, whilst professing to be theoretical only, without advancing any claims to be a new, or even too bold a theory, seems to me nevertheless applicable to this case. De Geer has put forward the idea, that the secular elevation which is going on in northern Scandinavia is caused by the elastic recoil of the earth's surface, returning to its original position after getting rid of the dead-weight of its glacial covering in the Ice age. If now this ice-cap, which is, I admit, inconceivably more compact and inconceivably heavier, than the sands of the Takla-makan, was able to exercise so stupendous a pressure upon the underlying primitive rocks, then it is a fair question, whether the pressure of the superincumbent sand in the desert just mentioned does not, though on a very much smaller scale, exercise a certain amount of pressure upon the substratum on which it rests. Confining our attention to that part of the desert which is bounded on the west by the line of continuation of the Nija-darja and the lower course of the Kerija-darja, on the north by the Tarim, on the east by the Tarim and the Ettek-tarim, and on the south by the Tschertschen-darja and the forest-belt of the astin-jol, or great southern road, we have a region measuring 110,000 square kilometers. If now two-thirds only of this area is covered with sand, we get a base equal to 73,300,000,000 square meters, and if we put the mean altitude of the sand-accumulations at 70 m., we obtain a mass of 2,565,500,000,000 cub. m. of sand. A cubic meter of ordinary sand weighs say about 1,700 kg., so that the total weight of this mass of sand is equal to 4,360,000,000,000,000 kg. Possibly this immense weight exerts, as I have said above, a local pressure, which to some extent compresses the underlying substratum, and, if the sand were removed, the substratum would by its elasticity recover its normal position. But this does not happen: on the contrary, the pressure tends to increase, for the products of disintegration which originate on the mountains that encircle the basin of the Tarim

tend to accumulate in the central parts of the basin, as indeed is the rule in every internal drainage-basin wherever it exists. When we see the Chotan-darja and the Kerija-darja both moving to the right, i. e. towards the centre of the basin where the pressure of the sand is greatest, and when we see that the arc described by the bed of the Tarim tends, as it were in a series of concentric circles, to flit in the same direction, and that the lower part of its course, which formerly terminated in the Lop-nor, has subsequently made a gigantic bend towards the right, that is towards the centre of pressure of the sand, one is tempted to conclude, that the surface *is* depressed by the weight of the superincumbent sand, and that according as the surface sinks so does the river gravitate towards its centre (Pl. 52).



Fig. 255.

Let us now glance for a moment (see fig. 255) at the latitudinal section through the region of the lower Tarim, we cannot help noticing the strange fact, that the river has turned towards the part in which the sand is highest, and has left behind it the flat sand-free desert on the east, the level of which is still further lowered by the conjoint agencies of corrasion and wind-erosion. If now the pressure of the sand produces a depression in the centre of the basin, while disintegration and spring-floods build up screes or gravel-slopes on the flanks of the encircling mountains, and these are overlain transgressively by æolian dust, then obviously these powers co-operate together to shape the basin into a hollow saucer (see fig. 256). But



Fig. 256.

even when this result is achieved, the effect it produces is relatively slight in comparison with other agencies which are simultaneously operative, and that at a swifter and more energetic *tempo*. I have already spoken of the dust which is deposited every year in layers of respectable thickness over all parts of the basin. Large masses of solid matter are annually swept down by a long series of streams off the mountains along the southern border of the region we are considering, and carried by them towards the interior of the basin, the level of which they too help to raise. But the same thing is not true of the mountains on the northern border, because the Tarim comes like a protecting wall between them and the centre of the basin. We may therefore take it for granted, that the pressure which the sand *per se* does undoubtedly exert, and which by its incidence gives rise to a latent tension in the underlying substratum, was long ago counterbalanced by the elevation of the same

underlying substratum through the accretion of fresh matter. And the determinative laws which govern the river's instability are inherent in its own properties and its power of depositing silt; these produce changes much more quickly, as well as changes of a more thoroughgoing character, than the secular elevation or depression which the surface can undergo in consequence of the action of any other natural agent. At any rate it is certain, that the resultant tendency of the movements of matter in this region, whether they are initiated by the winds or are directed by the water, is on the whole to level and fill up the basin. The process is in reality that which is represented schematically in fig. 257, where the portions indicated by little circles represent the detritus slopes on the mountain-sides which become transgressively overlain by strata of æolian loëss, and *vice versa*. The drift-sand, which is perpetually in motion, participates in the work of general elevation that is going on, and thus clings for the most part to the surface of the central parts of the basin.

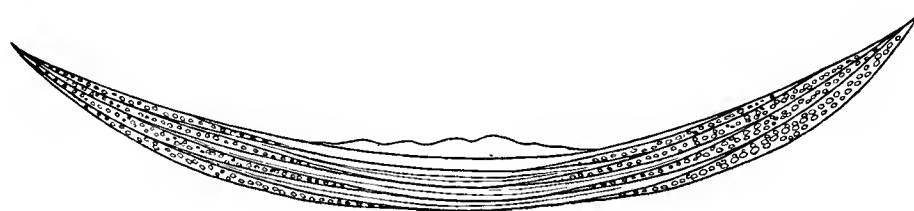


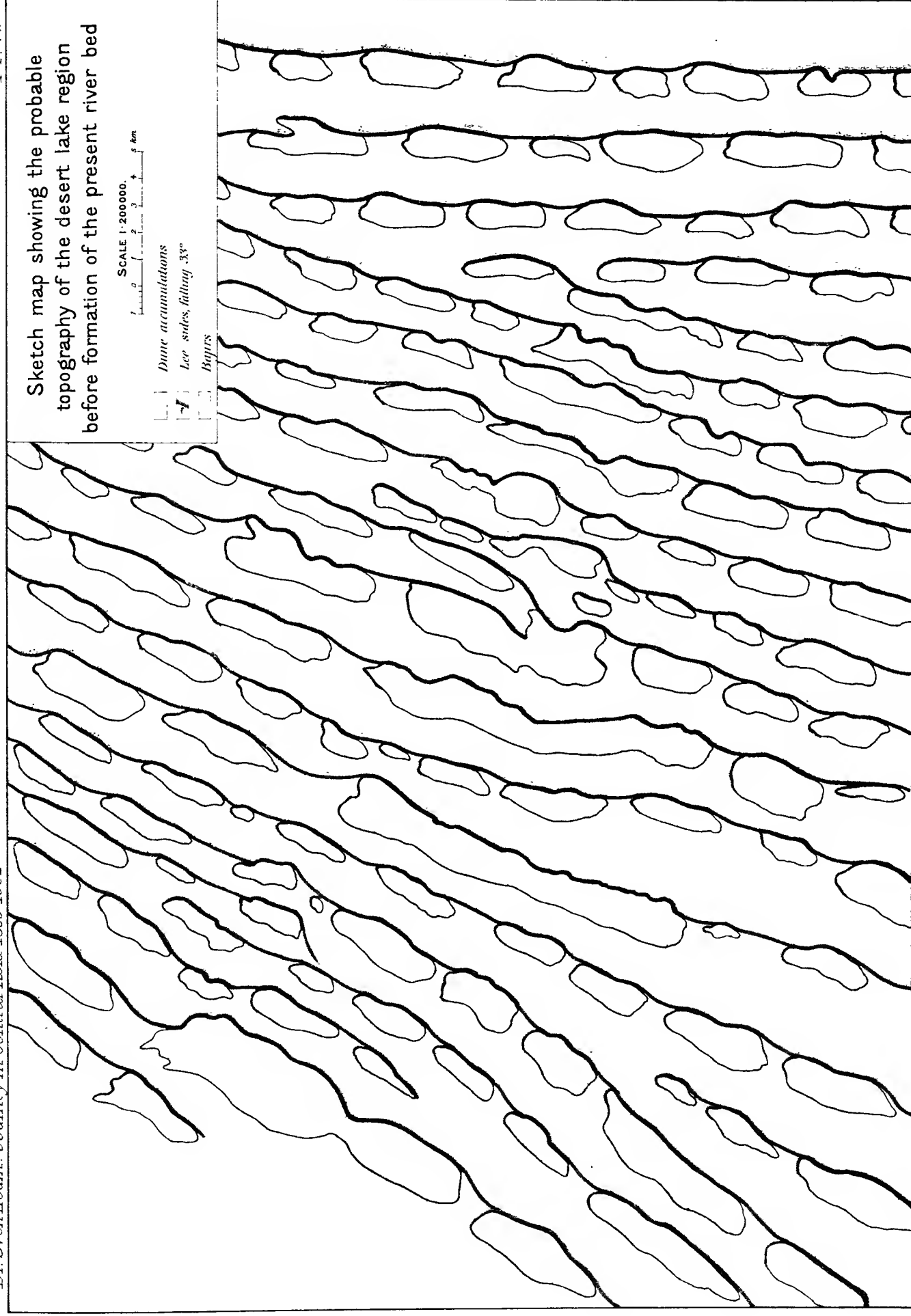
Fig. 257.

Returning once more to our six lakes — I have said, that as a rule the longer axis of each lake extends from north-north-east to south-south-west. Their parallelism does not however hold good throughout, as will be seen from the subjoined table, in which the compass-bearings indicate the direction of the major axis of each of the lakes; and although no allowance is here made for the variation of the compass, yet as that may be taken to be the same in every quarter, the several directions are nevertheless mutually comparable.

Sejt-köl . . .	= N. 29° E. — S. 29° W.
Basch-köl . .	= N. 25° E. — S. 25° W.
Jangi-köl . .	= N. 15° E. — S. 15° W.
Gölme-käti . .	= N. 23° E. — S. 23° W.
Karaunelik-köl	= N. 16° E. — S. 16° W.
Ullugh-köl . .	= N. 6° E. — S. 6° W.
Begelik-köl .	= N. 1° E. — S. 1° W.

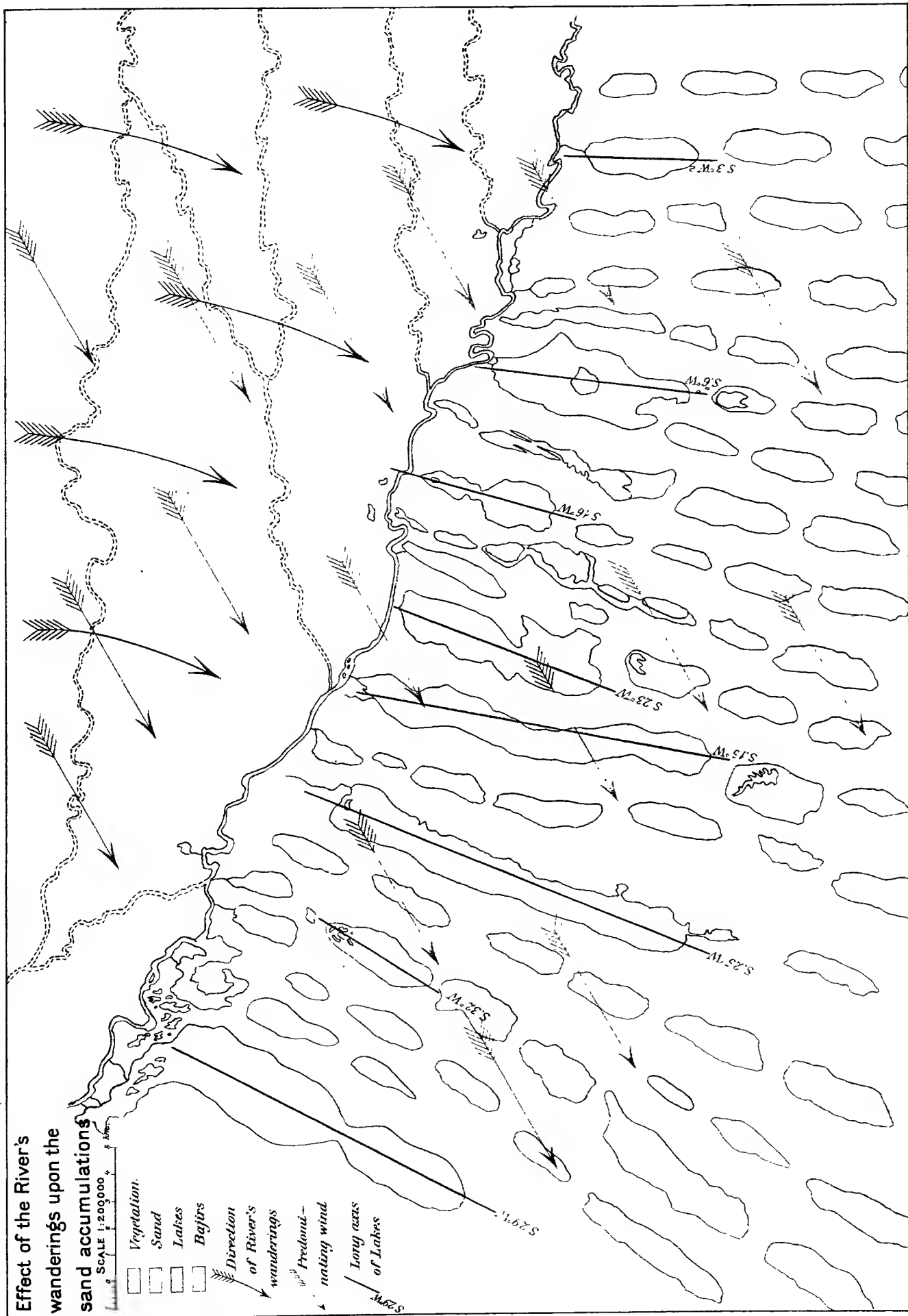
That is to say, as we advance down the river, the position of the major axis of the lakes tends to approximate more and more to the meridional, which is indeed the actual position of the chain of lakes — the Avullu-köl, Kara-köl, Tajek-köl, and Arka-köl. The only exception is the Gölme-käti, which has almost the same orientation as the Basch-köl. The explanation of the changing positions of the lakes as indicated in the above table must be sought in the orientation of the desert bajir-depressions as a whole; consequently the investigation of this problem must be deferred to the chapters which deal with the Tschertschen Desert.





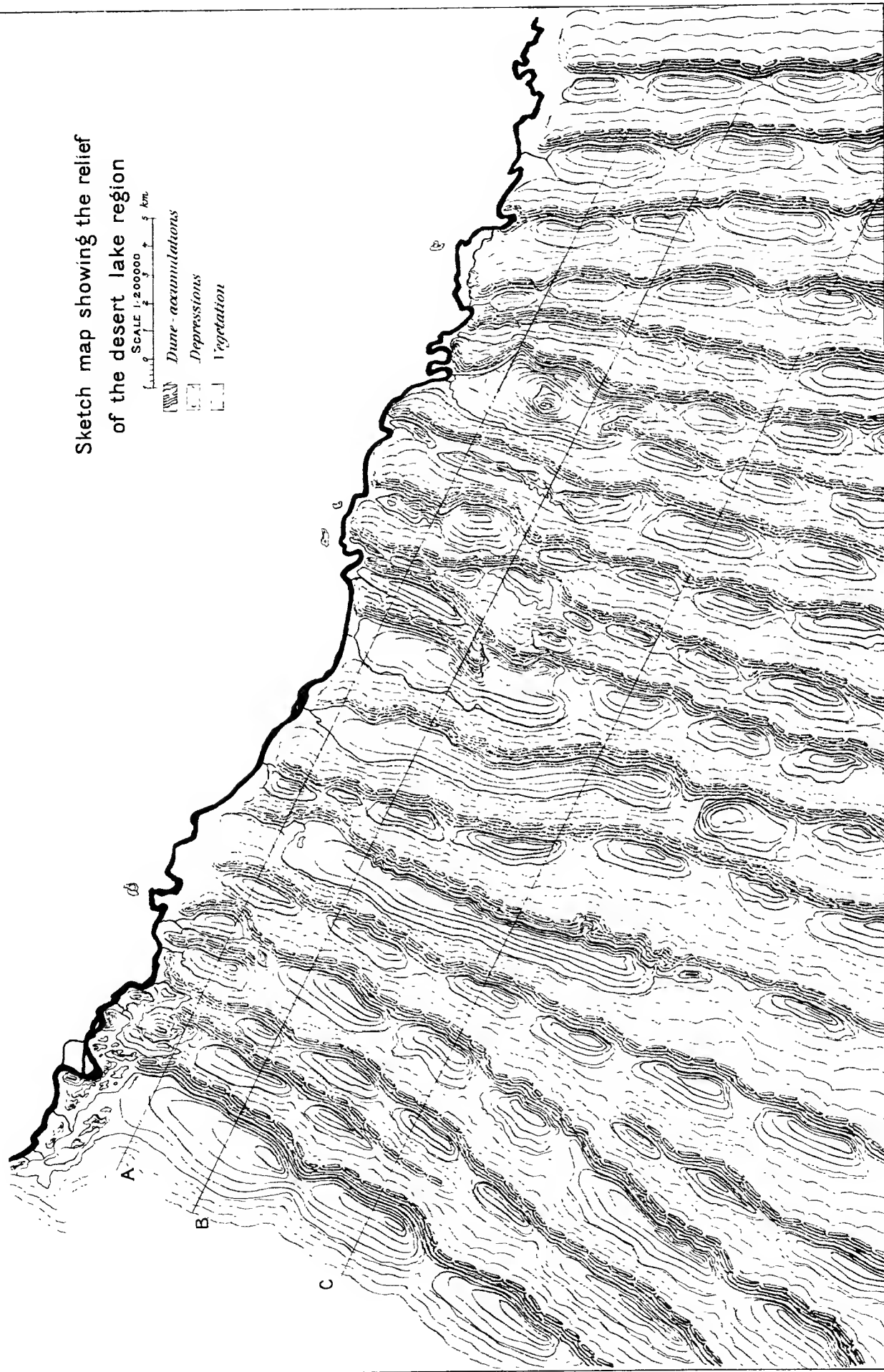


**Effect of the River's wanderings upon the sand accumulations**



六







For the sake of clearness let me now gather up the principal results to which the above inquiry has brought us.

(1) Between Karaul and Basch-arghan there is a chain of lakes, at least 35 in number.

(2) They are fed by the Tarim through connecting channels.

(3) Consequently they possess fresh water, which becomes slightly brackish when their connection with the river is severed, but is, owing to its stationary condition, as clear as crystal.

(4) Their existence proves that the strip of land along the right bank of the Tarim lies at a lower level than the river.

(5) Each lake occupies an independent depression lying between two elongated dunes.

(6) Each of these depressions is deepest in its south-east part, and has a deep trench along the leeward slope of the dune on its eastern shore.

(7) The western and northern parts of each lake are shallow.

(8) The farther down the river the lakes lie, the greater grows their maximum depth, but the less their mean depth.

(9) As a rule the breadth increases, and the length decreases, the farther the lakes lie down the river. The proportion of length to maximum breadth is 8.0 : 1 in the Basch-köl and 2.8 : 1 in the Begelik-köl.

(10) In three lakes that were sufficiently measured, the volume increased the farther the lake lay down the river. This is however an apparent law merely, and is simply due to the lakes selected. If we take the mean depth of the Jangi-köl as equal to that of the Karaunelik-köl, its capacity will be 120 million cubic meters.

(11) The sides of each lake-basin are cemented by matter partly of fluvial, partly of æolian, origin.

(12). Beyond the inner, that is to say the south-south-west, end of each lake there is a bajir or depression exhibiting the same characteristics as the lake-basin itself, except that it contains no water. If there is water, the depression is called *daschi*, or »salt-pool».

(13) The size of the connecting channel is proportional to that of the lake. Sometimes there are two, and even three, canals. The length of the canals which feed the lower lakes appears to be greater than the length of those which feed the upper lakes.

(14) All the lakes receive an inflow of water at the periods of high water, unless their canals are dammed by the natives, or the lakes are isolated by a change in the course of the river.

(15) In their topography the lakes reproduce the contours partly of the adjacent sandy desert, partly of the substratum.

(16) The depressions were originally caused by wind-erosion and their situation in the trenches of the substratum, i. e. the everywhere predominant direction of their major axis from north-north-east to south-south-west, was originally caused by the prevalent wind blowing more or less at right angles to the main axis of the dunes.

(17) Several of the lakes are contracted and narrow in the middle, a result attributable to the festoon-arrangement of the dune-chains.

(18) The lakes are of no great age, because the river itself has not long flowed through that region.

(19) On both sides of each lake, east as well as west, there is generally a narrow strip of vegetation, the former owing its existence to the protection it enjoys against the wind, the latter to the wide berth afforded in consequence of the drift-sand having been blown away by the wind so that it does not smother the vegetation. This vegetation has been brought to these regions, which formerly were absolutely sterile, by the waters of the Tarim.

(20) The lakes are full of fish, and fishing is carried on in several of them, though, since the natives have devoted themselves to agriculture, not to the same extent as formerly.

(21) The highest dune I measured in this region had an altitude of 89.5 m. and the greatest depth sounded amounted to 14.0 m. (at Markat). Thus the greatest vertical difference of elevation is 103.5 m., in fact this was the greatest vertical difference of elevation I measured throughout the Lop country. It is of course possible there may be an even greater depth locally in one or other of the lakes, and that one or other of the dunes may stand a little higher, but the difference will in no case exceed a couple of meters or so above the 103 m.

(22) As regards the future of these lakes, it may be taken for granted that they are doomed to perish, either through the advance of the dunes or the instability of the river. Their existence is in any case precarious, and represents merely a passing phase in the history of the development of the lower Tarim.

(23) If through any cause they should disappear, it would result in an increase in the extent and volume of the Kara-koschun. Their enlargement, being a consequence of the raising of the river-bed, has resulted in a diminution of the area of the Kara-koschun during the period in which it has been subject to observation.

Finally, a few words ought to be added with regard to the nomenclature of these lakes. Simple as their names are, they are frequently very expressive, and in two or three words throw valuable light upon the origin of the lake, or upon the properties which are characteristic of it.

Several of the names tell us indeed nothing at all; this applies especially to those which are compounded of a personal name and the word *köl* = »lake», as Aghesi-köl. A name like Tana-baghladi-köl, if it tells us nothing else, does tell us at any rate that the lake was cut off or isolated by a man of the name of Tana. Talei Kullu-tschapghan may mean either the Canal of Talei Kullu or the Lake Dug by Talei Kullu; it is at least certain that a man of this name was once busy here with his spade.

Tajiri-kakmasi, which means the Fishing Bay of Tajir, has been applied to an entire lake. Kotschkatschi-köl is either Kotschkatsch's Lake, Kotschkatsch being a man's name, or the Swallow Lake. Some of the names have to do more or less directly with fish and fishing, as Gölme-käti, the Lake of the Lost Fishing-Net; Talaschti-köl, or the Disputed Lake, the lake in which the rights of fishing were in dispute; Begelik-köl, or the Beks' Lake, chieftains alone being allowed to put down their nets there; Baschtage-köl, a name which, like Basch-köl, admits of two meanings, either the Upper, as compared with some other lake situated »lower» down, or the



Most Important, owing to its especially plenteous supply of fish. Torpak-öldi, or the Calf Died, is like Gölme-käti, in that it contains an allusion to a very trivial occurrence which happened on its shore.

The remaining names speak of properties which are more directly characteristic of each lake, as Teis-köl, or the Shallow Lake, suggesting that it would be vain to expect to find any great depth in it. The name Jangi-köl indicates that the lake which bears it is a recent creation, or at any rate has been formed more recently than its neighbours. Toghraklik-köl, again, suggests that poplars probably grow more abundantly on its shores than elsewhere. The Ullugh-köl, or the Big Lake, certainly is bigger than its neighbours. The compound Bajir-köl contains a contradiction in terms, for whereas *köl* signifies a depression that contains water, *bajir* signifies a depression that is without water. Hence we may surmise, that this name, which occurs three times, points to something intermediate between the two, a depression which contains water periodically only, and probably dries up entirely between the two seasons of high flood. Kum-köl, or the Sand Lake, is a common designation applied to all these lakes because they are surrounded by sand. Jallang-dschajir, the Bare Pool, is no doubt so called because of the absence of vegetation. Tschapghan-köl, the Dug Lake, is much too pretentious a name, for of course it is only the feeding-canal which has been dug. In Laj-baskan-köl we have an interesting name, meaning the Lake Filled up with Silt, and indicating that plentiful deposits of sedimentary matter are often enough deposited in it. The Ettek-köl, or the Western Lake, is so called because it lies west of Arghan; and the Ettek-bajir derives its name very appropriately from the circumstance that it is considered to begin the chain of lakes along the river, being the westernmost of the entire string. The first part of the name Uja-köl points to the dense thickets of reeds in which the wild-duck and wild-geese are wont to make their nests; and the name tells us consequently that the lake is surrounded by thick reeds. The natives know intimately where all these *uja* are, for they are wont to plunder them every spring, the eggs of these birds forming one of the most important parts of the sustenance of the Lopliks. As for Schikak I confess I am not quite positive about it; I was informed, that it is the name given to a place where one lies in wait (*schikamak*), i. e. for fish so as to spear them.\* The first part of the name Ghodsche-tutghutsch-köl is used to indicate the feathers and wing-feathers (pinions) of the wild-duck and wild-goose. When these drop out, the birds can be caught (*tutmak* = to take, to seize) by hand from the canoes. With regard to other lakes, not included in my list, as they are only portions of larger lakes, I will once more refer to Lakuluk-köl, another name which has a direct connection with fishing, for *laku* is the biggest species of fish which lives in the Tarim and its lakes, whereas the smallest species is known as *balik*. For Tuvadake-köl, the Lake of the Hills, I could see no reasonable justification, for the lake is surrounded by sand-dunes only, precisely like those which encircle its neighbours, so that in this respect there exists nothing distinctive.

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\* Possibly we have here a corruption or reminiscence of the Persian word *schikari*, a »hunter«, which by some means or other has managed to stray into these distant regions, and has been applied in the way suggested.

And herewith I will leave these lakes. It would be very interesting to visit them again in ten or twenty years' time and ascertain in which direction their development is tending, whether the river is minded to pour still greater quantities of water into the desert, or entirely to withhold from them its maintenance. One visit like mine is indeed sufficient to tell us what a country such as this is like, but only a second visit can supply data for deducing reliable conclusions regarding it. I have deliberately dwelt at length upon these lakes, because they contribute in a high degree to the understanding of several other problems in this same region, to wit the bajir depressions and their relief, the progress of the dunes, the river's caprices, and the continuous shrinkage of Kara-koschun.



THE TARIM AND THE DASCHI-KOL.

# THE TSCHERTSCHEN DESERT



## CHAPTER XX.

### THE BAJIRS.

In the preceding chapters I have spoken of two or three excursions which I made to the desert lakes, for the purpose of ascertaining the best point to start from when crossing the sandy desert, that is to say, where the best use could be made of the level floor of the bajir depressions. But I obtained no positive result, for the conditions south-west of all these desert lakes were precisely the same: there was at least one bajir forming a continuation of each lake, so that it was immaterial where we made our start. After having myself visited, or had reconnoitred for me, all the large lakes, I finally chose a new route, by way of a lake which I had not seen, namely the little Tana-baghladi-köl.

Upon the purely practical side of my preparations for this journey I need not dwell, because I have already described them in the popular account of my travels. I will only say here, that we carried with us from the river a plentiful supply of ice, for we did not expect to find water in the interior of the desert, as also a supply of fuel, for in all probability the desert would be absolutely barren. The caravan consisted of seven camels, four men, and two dogs, though we also took with us one horse by way of experiment. The men tramped the entire distance on foot, and I only rode along the bajirs.

From what we had already seen of the desert from the river — a region majestic in its desolation and studded with the lofty dunes which I have already described — we fully anticipated a hard and difficult journey; indeed I was quite prepared to lose the whole of my caravan, as I did in the Takla-makan in 1895. That the expedition turned out beyond expectation successful must be attributed to the prevailing wind, and the advantageous manner in which it had disposed the big sand-waves.

According to the large map of the boundaries of Russian Asia, issued by the Topographical Division of the Russian General Staff, the distance from the Tarim at Tana-baghladi-köl and the imaginary town which Roborovskij heard speak of, and placed on an older bed of the Tschertschen-darja, amounted to 230 km., and from this latter point to Tatrau was another 64 km.\* It is true, I hoped that we should

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\* According to the map which General Pjevtssoff gives in his book on his Tibetan expedition, the distance between the Tarim and Tatrau is also 294 km.

derive some assistance from the old bed of the Tschertschen-darja,\* the real value of which we shall see in a subsequent chapter, and that by digging in it, if it was not entirely sanded up, we might obtain both water and fuel, or even grazing for our animals. All the same I did not dare to count too much upon a statement that rested upon hearsay only. According to my own map (constructed and drawn by Dr. B. Hassenstein, in *Peterm. Mitteil.*, Ergänzhft. No. 131) the distance between Tana-baghladi and Tatan, as the crow flies, is 285 km. In the following table I have entered in kilometers the distance travelled on each of the 18 days that our journey lasted, as well as the components of the compass-bearings. Our real starting-point was our winter-quarters at Jangi-köl, but the distance of the first day's journey to Camp No. I is counted from the Tarim end of the Tana-baghladi canal.

Date.	No. of Camp	Distance in km.	Direction.	Distance from the Tarim in km.
1899. 20 Dec. . . . .	I	3.2	S. 20° W.	3.2
21 " . . . . .	II	16.6	S. 37° W.	19.8
22 " . . . . .	III	22.3	S. 35° W.	42.1
23 " . . . . .	IV	19.9	S. 15° W.	62.0
24 " . . . . .	V	15.5	S. 13° W.	77.5
25 " . . . . .	VI	18.2	S. 3° E.	95.7
26 " . . . . .	VII	21.8	S. 14° W.	117.5
27 " . . . . .	VIII	7.9	S. 14° W.	125.4
28 " . . . . .	IX	13.3	S. 12° W.	138.7
29 " . . . . .	X	14.3	S. 3° W.	153.0
31 " . . . . .	XI	24.3	S. 16° W.	177.3
1900. 1 Jan. . . . .	XII	14.4	S. 9° W.	191.7
2 " . . . . .	XIII	21.9	S. 13° W.	213.6
4 " . . . . .	XIV	18.0	S. 14° E.	231.6
5 " . . . . .	XV	15.9	S.	247.5
6 " . . . . .	XVI	10.6	S. 13° W.	258.1
7 " . . . . .	XVII	9.7	S. 2° E.	267.8
8 " . . . . .	XVIII	16.7	S. 14° E. + S. 49° W.	284.5

Camp. No. XVIII was situated in the district of Keng-lajka, on the left bank of the Tschertschen-darja, 7 km. below Tatan. Our failure to hit this village exactly was due to the variation of the compass. According to my measurement the total distance amounted to 284.5 km. That this agrees within 500 m. with my map in *Peterm. Mitteil.*, in the compilation of which Dr. Hassenstein made use of all the

\* Roborovskij states, he was told, that there was a road through the desert from the district of Boghuluk to the ruins of a large town which was reported to be buried in the sand two days' journey from Boghuluk, beside the old bed of the Tschertschen-darja, this last being still easy to trace. The road alluded to then continued from the ruins through Boghuluk and Vasch-schahri to the lake of Lop-nor (*Trudij Tibet. Eksp.*, iii. pp. 68 ff.).

In Ergänzungsheft No. 131 to *Petermanns Mitteilungen* (pp. 139 ff.) I relied too much upon this statement, which appeared to agree so well with the migrations of the lake of Lop-nor. Moreover in his map Roborovskij has laid down the lower course of this old river-bed, putting it at 60 versts from the lower Keng-lajka. I confess I was unable to discover a trace of this old river-bed, and doubt altogether whether it exists.

available materials that existed in 1899, may to some extent be a coincidence, as the errors in my compass-bearings and other topographical observations would seem to have neutralised each other. At the same time the approximate agreement bears testimony to the exactitude of my calculations of distance. The following instance will give an idea of the very simple method I employed in making my calculations. One camel, bearing always the same load, was used as »pace-reckoner». To traverse a base of 150 m., measured with the tape, he took

on 21st Dec. 3 min. 10 sec. in heavy sand

» 28th » 2 » 25 » on a level bajir with low sand

» 29th » 2 » 30 » on moderately sandy level ground

» 31st » 2 » 10 » on slightly undulating, but gradually ascending, hard sand

» 1st Jan. 2 » 15 » on a level bajir.

With the view of keeping a check upon these measurements, we measured our base-line afresh every morning that the character of the ground altered. The datum thus obtained was applied several times during the course of each day's march, and the results so obtained were afterwards used for striking a mean value, which was then taken as the standard for the hours and minutes during which the camel had travelled in the course of the day. In making this final calculation, we were always careful to deduct every stop that was made for rest, even the shortest. I also employed similar methods for my riding-horse, and for myself when I travelled on foot; thus when I went away from the caravan to reconnoitre, I was entirely independent of my »pace-reckoner», the camel. The number of compass-bearings that I took during the day's march naturally varied with the nature of the ground we travelled over. When moving along a level bajir it would suffice to take the bearings every half hour, or the intervals might even be longer, but in the sand I found it advisable to take them every two or three minutes, or even sometimes every minute. For instance on 22nd Dec. I took 48 compass-bearings in all, and the time we were travelling was 5 hours 41 minutes, so that on an average one compass observation was taken every 7 minutes. The longest period we travelled in the same direction, or in other words the longest interval between two compass observations, was in point of fact 32 min., and the shortest only one minute.

I propose in the immediately following pages to give, first a description of our journey across the desert, and after that to summarise the results of my observations. I regret I have nothing better to offer than a general description of the desert's appearance; but it must be remembered, that it is a dangerous thing to venture to cross a desert such as this, so extensive, so unknown, and with the distances everywhere so great from the centre to the periphery. On such a journey you have neither time nor opportunity for making measurements and determining levels with minute precision. We were frequently obliged to travel on foot, and at the end of a long day one is tired; besides, the one engrossing thought is whether one will succeed in reaching the other side of the desert at all. I feel it a particular source of regret, that the weather proved an almost constant hindrance to photography.

Starting on 20th December I made my way along the right bank of the Tarim, and then to the southern end of the Tana-baghladi. This is separated from

a fairly large pool in its first bajir, which is small, by a narrow and very low strip of sand. The water in the pool was quite salt, utterly undrinkable; but in spite of that, it was covered with a sheet of ice. Thick, luxuriant kamisch grew all round it, but nothing else, not even tamarisks. As we might assume, that this was the last spot where we should find grazing for our camels, we decided to halt there.

On 21st December the direction in which we travelled was dictated entirely by the situation of the bajirs. These resembled in points of detail the desert lakes I have recently described, except that their major axes, which we followed, leaned more decidedly towards the south-west. Had they maintained the same direction throughout, we should have been led a long way to the west of Tatan and should have emerged in the desert of Nija; but our main object was to make use as long as we possibly could of these depressions, these gigantic troughs drawn between and amongst the accumulations of the sand. There was a crisp breeze from the south-west, and the sky was clouded; when the wind lies in that quarter it sweeps through the bajirs from end to end unchecked.

At its south-west extremity the pool beside which we had encamped was parted from the first real bajir by a very low threshold or isthmus of level sand. At the north-east end of this there were several small shallow pools of salt water, surrounded by incrustations of salt. Wherever such pools are present in a bajir, they always occur at the end nearest the river; it is of course from the river that their water comes. South-east of this bajir lay another containing a small patch of kamisch. Bajir No. 2 was smaller than No. 1, and as No. 3 was smaller still, I began to fear we should soon have to take to the high sand. Great therefore was our surprise to find that bajir No. 4 was bigger than the first three put together. All these were separated from one another by isthmuses of sand, more or less high; the isthmus, or threshold, as I prefer to call it, between No. 3 and No. 4 was 1,270 m. broad, and bajir No. 4 was 6.1 km. in length. Thus a relatively small part of the day's journey lay actually across the sand, and the greater part ran through the bajirs, which in appearance at least were practically level ground. On this the second day we crossed four thresholds of sand, and traversed four bajirs. The dunes of which the thresholds were built up lay very conveniently for us, for the highest point was in the south-west, whence we went down by a steep descent into the next bajir. This conformation can only have been produced by winds from the north-east, the north-north-east, or the north. The south-westerly wind which met us during the day was not strong enough to alter the dunes to any appreciable extent. North-west of the head of the second bajir there are said to be two depressions, and beyond them the *bughas* or *bolta* of the Sejt-köl, that is, the narrow sound between the two basins of the lake. The first bajir of this lake lies almost due west from the threshold between bajirs No. 3 and No. 4. The level floor of the bajirs is often heavier to travel over, if that be possible, than the sand itself, for they are very often covered with fine yielding dust, into which the camels sometimes sank 4 decimeters, while it also whirled up in clouds in the wake of the caravan. The ground is seldom hard and firm to the tread, and even when it is so, it is only for short stretches. Another observation we made, was, that the ground grew softer towards the middle of the bajirs; hence we thought it best to travel along



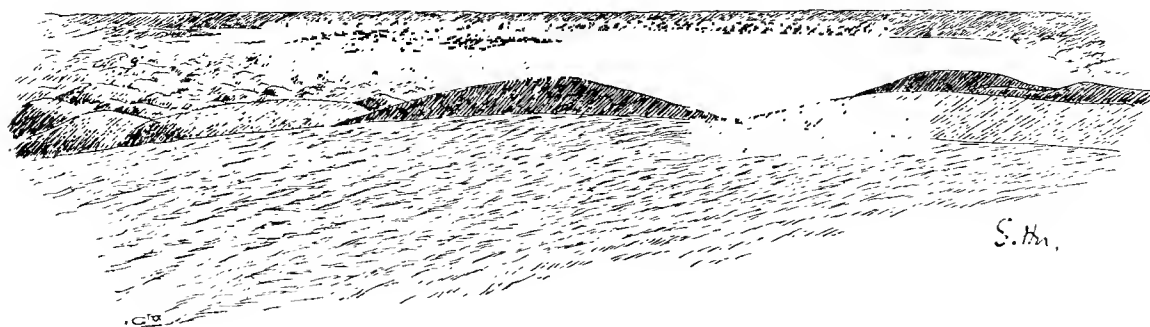


Fig. 258. PANORAMIC VIEW OF A BAJIR.

their outer margins, that is as near to the sand as possible, for the sand does impart a certain degree of hardness to the surface. On the longer south-east side of the bajir the dune generally plunges down towards the bottom at as steep an angle as it possibly can, namely  $33^{\circ}$ , whereas on the north-west it has a long and gradual slope. The outline of the bajirs is not perfectly regular, but is broken here and there by short, low spurs of sand, jutting out from the dunes towards the middle of the depression. But in general the conformations of the desert are characterised by an astonishing degree of regularity. The sand-free depressions lie end to end in a long string, and as you advance, you know precisely what the landscape will be like behind each successive threshold you come to. The picture which presents itself from the top of each of these ridges is an exact facsimile of that upon which you are turning your back. Of life there is not the slightest trace; neither leaf nor footprint can be detected anywhere. You are surrounded on every side by the silent and desolate desert. It would defy the boldest imagination to conceive a more dreary or more lifeless scene. That night we encamped amongst the dunes of the threshold which terminated the fourth bajir. Climbing to the top of a high dune near our camp, I perceived to the south-east some small bajirs belonging to another desert-trough than that which we were following, but, like it, equally surrounded by sand.

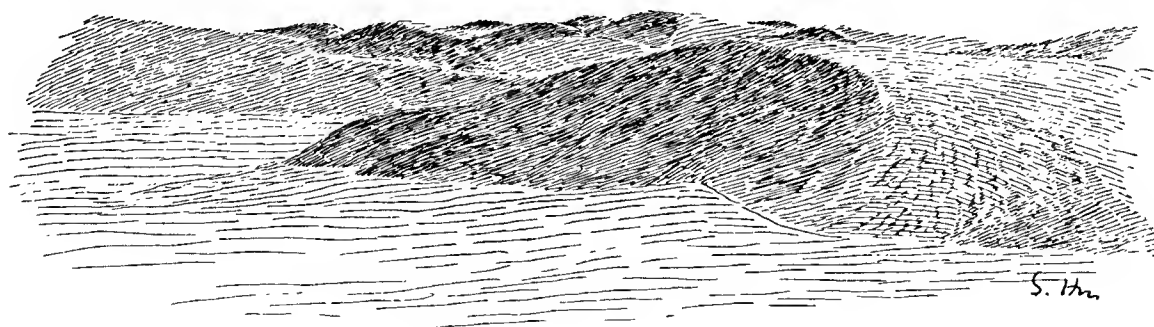


Fig. 259. INDIVIDUAL DUNES ON A SMALL THRESHOLD.

On the 22nd December, the greater part of the day's march, like that of the day preceding, led along the level bajirs, except for a very small patch of sand. In consequence of these bare depressions, the sand seemed to be arranged like a net, the bajirs answering to the loops. At first I fancied that the two systems of dunes which intersected each other were caused by prevailing winds blowing from two

different directions, an opinion to which I have called attention in my popular description. But further reflection has led me to doubt the correctness of this view as an explanation of the arrangement of the masses of sand and of the desert relief in general, except indeed in part. The circumstance that the thresholds or isthmuses of separating sand are built up each of an agglomeration of dunes, which melt together and are connected at a thousand different angles and in a thousand different ways, and that, at any rate at the season when we visited them, they turn very steep faces towards the south-west, are proofs that their structure is especially influenced by the north-east wind. The winds which predominate in this part of the desert all come from the north-east quarter of the compass, though at the same time the violent storms issue rather from the east than from the north. If, however, these winds are the sole originating causes of the thresholds coming into existence, we should expect to find the distances between them shorter, whereas we have already had one such distance of over 6 km. I believe therefore that they are, as I have reasoned in Chap. XVII, parts of the original windward flanks of the great on-moving north-east and south-west dune-masses, which are lagging behind, and that the retardation is due to the sheltering influence of lofty summits in the great sand-wave which follows immediately after them; these overtopping summits prolonging and emphasising the shelter which their own leeward flanks afford, in such wise that the outer parts of the windward side of the next following »wave» become less exposed to the wind, and consequently travel more slowly towards the west. But, once one of these thresholds is formed, it becomes exposed, like every other part of the sandy desert, to the north-easterly and south-westerly winds, and thus the arrangement to which I have alluded, with their steep faces towards the south-west is produced. On the other hand these thresholds are virtually protected against the violent easterly tempests. But I shall return to this topic again when I come to sum up the results of this excursion.

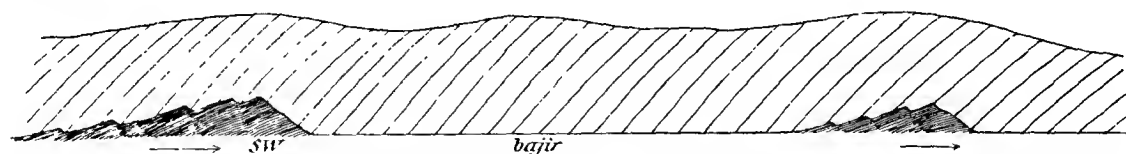


Fig. 260. VERTICAL SECTION THROUGH A BAJIR, FROM NE. TO SW. THE DARK PARTS ARE THRESHOLDS; THE PARALLEL LINES MARK THE STEEP LEEWARD SIDE OF A DUNE-ACCUMULATION.

Meanwhile my astonishment increased with each fresh bajir that opened out before us. The first impression which these bajirs produce upon the beholder, as he gazes down upon them, at all events it is true of those nearest to the river, is that they too must be desiccated lakes; but upon penetrating farther into the desert, and finding that the same regular architectural laws still continue to govern their formation, he becomes convinced, that what he sees is due to the effect of the wind, and that the lakes are, so to speak, a mere chance occurrence, their existence depending solely upon their accidental propinquity to the river. But for travelling across a desert no more favourable formation could be wished for than that of these bajirs. What a difference as compared with the abominable surface I had to travel over in the Takla-makan Desert! Not more than one-quarter of the day's march was through

actual sand, the remaining three-quarters lay along the level bajirs. So far we had encountered no hindrance; all the same we could not shut our eyes to the fact, that the thresholds grew both higher and broader as we advanced. Camp. No. II was but a short distance from the next threshold, and from the top of it we saw before us bajir No. 5, which was rather small. Upon reaching its south-western extremity we found there was a change in the consistency of the ground, in that the bajir was bordered by fringes of firm and moderately hard clay soil, compounded of extremely fine matter of a yellow colour. This had been originally deposited as a horizontal layer, and was now  $1\frac{1}{2}$  m. above the general floor of the bajir. Sometimes these edgings or cornices were like the sharp-cut erosion-terraces or scarped shores of some dried-up lake, while at other times they resembled »benches» and »tables», or the ruined walls of houses constructed of adobe or clay. At a little distance they bore a very close resemblance to the yellowish grey clay walls which surround the courtyards and orchards of East Turkestan, and more than once I had to subject them to close scrutiny before I could satisfy myself that they really were not the work of human hands. If traces of aqueous erosion ever were discernible on their surface, such were finally obliterated a long time ago. The only thing which pointed to the former presence of water was the horizontal position, still quite di-

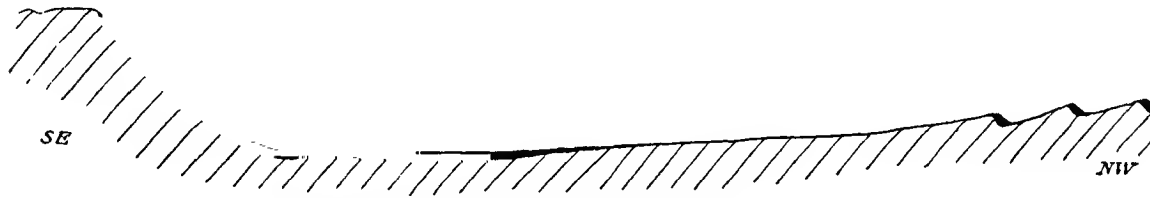


Fig. 261. THE BLACK SHOWS THE SOFTEST PARTS OF THE DUNE-ACCUMULATIONS AND BAJIRS.

stinguishable, though the clay through corrasion has been sculptured into rounded forms — pits, shallow basins, and knobby hills. Immediately south-west of these clay formations, which indeed have many features in common with the *jardangs* of the Desert of Lop, we had the next threshold. It was rather broad and high, and possibly covered several similar clay ridges. Then came bajir No. 6, which was pretty big. In these bajirs the breadth is more uniform than the length: for instance, No. 6 was nearly 6 km. long and its breadth about  $1\frac{1}{2}$  km., and No. 5, which was much shorter, had about the same breadth. Hence the breadth may be regarded as a tolerably constant factor, governed as it is by the breadth between the dune-chains, and the troughs hollowed out between them. In the south-east of bajir No. 6 we again found clay terraces, as we also did in No. 7, a bajir about the same size as No. 6, and parted from it by only a very narrow threshold. No. 8 was rather small, and, unlike those which preceded it, had its clay terraces at its northern end, while in two or three places in its interior there were rudimentary dunes. From and after No. 6 the ground in each bajir became firmer, so that it was possible to cross it in any direction whatever without sinking in too deeply. Still, it was always softest in the middle, or rather along a line which ran somewhat nearer to the eastern edge of the steep leeward side than to the windward side of the next dune-chain. It is here therefore that the greater part of the loose dust falls, and if the ground

is moist up to the surface it remains there, otherwise it blows away. Along this same line we accordingly find the deepest places in these depressions, although the differences of elevation are so slight as scarcely to be evident to the eye. As we advanced, we noticed a gradual diminution in the amount of moisture in the successive depressions. In the first, the one nearest the river, there was a freshwater lake, the Tana-baghladi; in the second a salt-water pool. In bajir No. 1 there was a tiny salt pool at its north-east end. In those which followed the surface was so loose, and the underlying ground so softened by the moisture, that we should have been swallowed up as in a bog had we ventured into the middle. The first bajir in which the ground was everywhere firm and dry enough to bear us was No. 6. This circumstance was no doubt indicative of a very gentle rise in the level of the country we were traversing.

After having travelled, as we now had done, for three days more on level ground than on sand, we began to think that the former occupied the larger area of the two. But we had only to climb to the top of the first commanding dune to be undeceived. All we could see thence were two or three of the nearest bajirs; in every other direction, no matter which way we turned, there was nothing but sand — sand — sand! On the east the steep dune faces, on the west the gently ascending slopes; but the depressions behind them were hidden by dunes 90 m. high.

At the beginning of bajir No. 8 we lighted, strange to say, upon the bones of a camel, soft and greatly weathered. They could of course belong only to the skeleton of a wild camel. Except for this, we saw not the slightest trace of this desert animal, whereas farther to the west, around the extreme tentacles of the Kerija-darja, and still farther north, the wild camel is quite numerous. In bajir No. 5 we had observed traces of an antelope, which, having probably been frightened, had fled to this remote quarter for refuge. Its track appeared to indicate that it had returned the same way it came.

At Camp No. III we dug a well, and got plenty of water at a depth of only 1.20 m., but it was impregnated with salt; its temperature was  $+4^{\circ}.8$  C. At the spot where we dug the well, the soil was moist up to the surface, and the surface in places bore a slight incrustation of salt.



Fig. 262. A REST ON THE TOP OF A THRESHOLD.

Thus despite the intense cold which prevailed (see the Meteorological Diary), the ground was not frozen, but quite as soft and manageable as in the summer. Nevertheless it was firm enough, even in the moist places, to bear the weight of a camel. Thus we had here once more struck a moist vein, although the last few bajirs had been dry. Saliferous ground of this description, equally whether dry or moist, is called by the natives *schor*.

On 23rd Dec. we had a tempest from the north-north-east and it filled the air so full of dust-haze that we were unable to see anything of our surroundings except the summits of the nearest dunes. It is this wind which moulds the relief features of the thresholds, sweeping through the long, narrow troughs or hollows of the desert »ocean» without check or hindrance as through a piece of piping. At the thresholds however its velocity is rather accelerated than retarded, for as a general rule the long dune-trough is there somewhat contracted and narrow, so that the wind becomes compressed as in a defile. It now looked as though the great advantages which had hitherto been afforded us by the configuration of the ground were soon about to cease. The next threshold was very broad and very high, and bajir No. 9 was one of the smallest depressions we had hitherto crossed. Its surface was free from sand at its northern end only; in the middle and towards the south it was ribbed with small, low dunes, arranged as parallel ridges, running from north-east to south-west, and consequently not exactly parallel to the major axis of the bajir, which stretched from north-north-east to south-south-west. In height these ridges or swellings seldom exceeded one meter, and as a rule their outlines presented no sharp angles, but wore rounded forms. They appeared to have been shaped and built up by the east wind, and to have been altered by winds from other quarters. Bajir No. 10 had approximately the same area as its predecessor, and, like it, was grooved with small sand-ridges, especially in the middle, though not in the east. These miniature sand-dunes proved but little hindrance to our advance; not only were they quite hard, it was also quite easy to avoid them. If these two bajirs, No. 9 and No. 10, were to be filled with water, they would form a lake which in the details of its conformation would resemble the Karaunelik-köl — the same elliptical basins, the southern one a little the larger, the same narrow *bolta* connecting the two, the same deep trench along the east side, and the same shallow reaches along the west. The resemblance would also extend to the girdle of dunes which shuts them in. And, on the other hand, if the Karaunelik-köl were to dry up, and its narrow belt of vegetation to disappear, its basin would resemble precisely this couple of bajirs, Nos. 9 and 10. Thus the types of formation which prevail close to the river continue also for a long distance into the desert, and the water has nothing whatever to do with the origin and formation of the depressions; its presence in them is purely accidental.

A comparison between the threshold which parts bajir No. 8 from No. 9 and that which parts bajir No. 9 from No. 10 throws a good deal of light upon the matter, and supports the correctness of my view as to the origination of these sand-partings or saddles. The fact is, the second of these two thresholds did not completely separate No. 9 from No. 10; but there was a »sound», a species of *bolta*, about 100 m. across, situated quite close to the base of the steep leeward

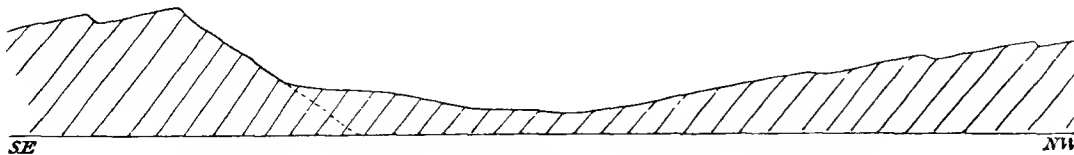


Fig. 263. VERTICAL SECTION OF A COMPLETED THRESHOLD.

side of the dunes on the east, and on this there was not a particle of sand. The tongue of sand, which we crossed at its extreme low end or tip, thus tailed away towards the east. It was quite evident, that this eastern tip, lying as it did under the shelter of a particularly big accumulation of dunes, had been checked in its advance, and was unable to keep up with the regular forward march of the westward dunes. Fig. 263 gives a section through the big compact threshold which parted bajir No. 8 from No. 9, and fig. 264 a similar section of its successor between bajirs No. 9 and No. 10. The latter fig. shows the stage out of which the former fig. has developed. Here too the tongue of sand becomes gradually covered, and so tends slowly to assume the form of relief shown in fig. 263. The intervening stages of the development can be conceived without any difficulty. The rate of movement of the eastern dune-mass becomes a trifle accelerated when it begins to climb up the tongue of sand, for the line connecting its summit with its base is then gradually shortened, and the space beyond is filled more quickly by the down-pouring sand, while that space itself grows less and less in proportion as the sand advances westwards up the tongue.

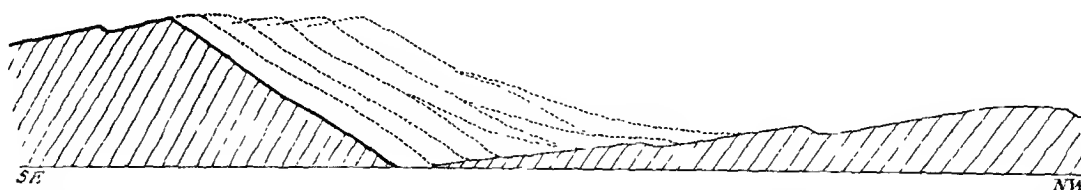


Fig. 264. VERTICAL SECTION OF AN UNCOMPLETED THRESHOLD, THE DOTTED LINES SHOWING THE PROGRESS OF THE LEE SIDE OF A DUNE-ACCUMULATION TRAVELLING UP OVER THE WINDWARD SIDE OF THE NEXT ACCUMULATION TO THE WEST.

I have already said, that the chains of dunes do not run in straight lines, but in festoons or a succession of long shallow bays, the cusps or horns of which are the parts most advanced towards the west, while the hollows of the festoons »hang back» as it were towards the east. As a rule these cusps or horns lie over against the tongues of sand. This disposition will explain also, why the thresholds between the bajirs are notched each by a gap or hollow in their middle, and are highest on the east, immediately at the foot of the leeward flank of the great accumulations of sand. This particular relief has an effect upon the direction and energy of the winds coming from the north-north-east and the south-south-west. The former sweep along the steep leeward flank (see fig. 265) until their progress is checked by the transverse threshold at the end of the bajir, and there a local »wind-screen» is formed by the cusp of the festoon. If however the wind is sufficiently powerful, it lifts the sand off the leeward flank of the great accumulation, sweeps it along its face, and drops it partly upon the threshold, partly on the sheltered side of the cusp. The same activity explains why the thresholds are narrowest in the middle and widen out towards the east, where they merge into the steep, leeward dune-flank, forming an inextricable chaos of dunes heaped in chaotic confusion one upon another. These, in consequence of the scores of different angles at which their constituent parts are built up and shaped, have never possessed any distinctive individuality, and consequently lack all those noticeable characteristics which recur with such amazing regu-

larity in those dunes that do retain their distinctive individuality, for these latter are not influenced by their surroundings, and the ground upon which they rest is level. There is however one feature which is repeated with unfailing regularity in the case of all the thresholds, and that is, that they descend towards the south-south-west at an angle of  $33^{\circ}$  ( $32^{\circ}$ — $34^{\circ}$ ). On this account an attempt to cross the desert in the opposite direction to the line I chose, i. e. from south-south-west to north-north-east, would encounter almost insuperable difficulties. At all events some of these steep faces could only be surmounted, that is if the traveller had camels with him, at the cost of incredible difficulty and a vast amount of spade-labour.

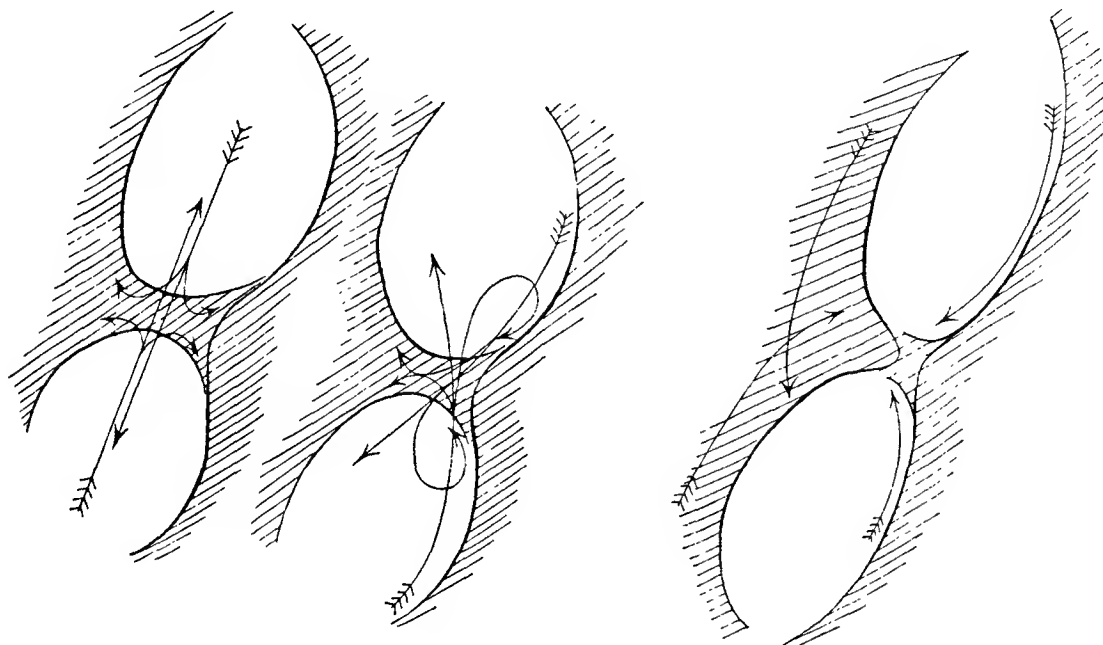


Fig. 265. PROBABLE DEVIATION OF NNE. AND SSW. WINDS OWING TO RELIEF OF DESERT.

The threshold between bajirs Nos. 10 and 11 covered quite as much ground as bajir No. 10 itself, and we were fully prepared to find the sand coming to an end and the sand-free ground disappearing altogether. And this expectation was still further strengthened, when we found that bajir No. 12 was quite small. Moreover it was shorter from north to south than from east to west, and its bottom was almost covered with small dunes, the only part free from them being that which lay next to the eastern leeward flank. In fact these tiny depressions were of little real assistance to us; for no sooner did we get down upon their level floor than we had to begin a toilsome ascent up the next threshold. The threshold at the end of bajir No. 12 was high and difficult. Imagine, then, my surprise, when from its summit I beheld, unrolled at my feet, a bajir of vast size, its farther end lost in the dust-haze. On its right or western side there appeared to be a *tumschuk* or »promontory» of sand, evidently the beginning of a new threshold, which, when completed, will eventually divide this big bajir into two. The floor of the bajir was composed of soft *schor*, covered with dust, and free from sand, except for a group of small ridge-like dunes stretching in the usual direction from north-east to south-west, and situated near the promontory I have just mentioned. Clay terraces peeped out in two places, one near

the same promontory, the other near the spot where we encamped. In the latter locality the ground was dry and hard, first-rate for travelling on; it was also slightly granulated, so that it crackled under the camels' feet, and in places had a thin coating of salt like rime-frost. On the actual site of our camp there was, immediately underneath the surface, a layer of salt barely 1 dm. thick, but as hard as a stone. The *jardangs*, walls, and tables of clay which still survived were rather more than 2 m. high. Every insular elevation was capped by a layer, perfectly horizontal, of yellowish red clay, of extremely fine grain, and two or three dm. thick. This deposit of recent clay-slate was relatively very hard, and therefore served to protect the underlying softer clay, which, of a greyish colour, sloped outwards all round, though the edges of the protective covering were everywhere vertical. Manifestly these two different sedimentary deposits were laid down under different conditions. So far as I was able to ascertain, both were destitute of organic remains. The bottom deposit resembled ordinary loess, while the upper one was like a marine sediment, — a case of »transgression» in miniature. It is evident therefore, that underneath the sand there must be buried an endless variety of different forms and layers of varying thickness. The inland sea which once covered these parts of Central Asia and of which the Lop-nor lakes may be regarded as a last surviving remnant, has undoubtedly, experienced just as those lakes are experiencing now, a series of different oscillations, periods of increasing and diminishing volume, although on the whole their resultant tendency is towards destruction. Hence we may expect to find the stratification changing to a certain degree, although the æolian loess must of course be the predominant »transgressive» member. In the case of some of the clay beds, which only project very slightly above the ground, the dip is however as much as  $28^{\circ}$  S.  $40^{\circ}$  W.; but these ridges are too small to allow of a definite opinion being formed as to whether this angle is regional or merely local; it may be, that it is the result of former sand-pressure, now removed, owing to the forward movement of the superincumbent masses of sand. In any case the clay hills with level surface, of which one is represented in fig. 266, owe their present shape to the wind: they are, as it were, the ruins of ancient sediments, which have now mostly disappeared.

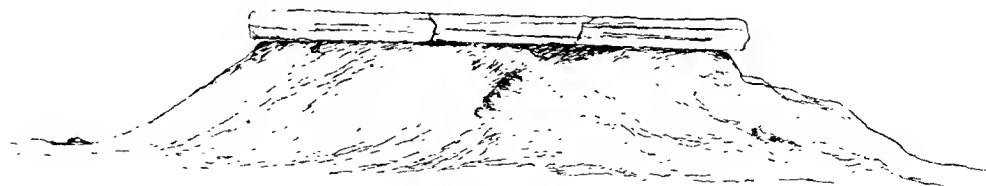


Fig. 266.

If the portion of bajir No. 13 which lies south of the sandy promontory were to be filled with water, it would form a lake of precisely the same shape as the Ullugh-köl. Thus we find here again, amongst these dry depressions, the same irregularities as occur amongst the desert lakes that we recently discussed. The only difference is, that the Ullugh-köl has a sandy island in the middle and a peninsula at its southern end, whereas I have never found elevated and detached pieces of



sand in the middle of a bajir. But, as I have already stated above, the origin of the sandy island in the Ullugh-köl is to be explained in a different way.

December 24th. In the southern part of bajir No. 13 there was a projection or spur of the eastern dune-wall, and immediately opposite to it on the west side the beginning of a fresh threshold. Here, strange to say, some small dunes of irregular shape had formed near the eastern edge of the bajir; otherwise these eastern parts are just those which, enjoying protection against the wind, are generally free from sand. The exceptions to the rule have evidently been formed by the north-north-east and south-south-west winds, the manner of their origination being shown in fig. 265.

Bajir No. 14 was almost entirely sanded up, the only places free from sand being two or three small patches. This was in part due to its own small size, which had caused it to be encroached upon by the two sandy thresholds which shut it in on both north and south, and in part to the pronounced festooning of its eastern dune-wall, the cusp which came nearest to the northern threshold being especially prominent. Bajir No. 15, in spite of the great number of small dunes in its northern half, proved a good friend to us. These dunes were of two different types — some the ordinary ridges running from north-east to south-west, others ideal crescents in

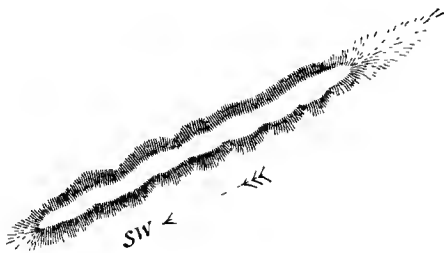


Fig. 267.

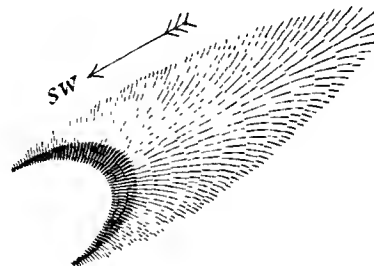


Fig. 268.

outline, with both their horns pointing towards the south-west. As a rule, the small dunes in the bajirs originate, as for instance in Nos. 11 and 12, only on the west side, where the wind has freer play than under the steep leeward flanks on the east. Towards the south end of bajir No. 15 there were other table-like *jardangs* of clay, similar in appearance to those recently described, and in addition to them step-like terraces of clay. All these are of course the surviving fragments of a once extensive formation, which has been cut down and planed away by corrasion. On the whole these fragmentary survivals are very rare, although there are no doubt numbers of them buried under the sand. They have precisely the same appearance as the clay scarpments or edges which I encountered in the Takla-makan Desert. Possibly it is a pure chance, that they are almost entirely confined to the southern parts of the depressions, whilst, with one exception, they are entirely absent in the northern parts. But very likely this, again, may be a result of corrasion, for if there is any part of these bajirs which is accessible to the north-east and north-north-east winds, it is their southern end. In that quarter the winds' action is more of an excavating character; that is, it cuts in deeper and so causes the harder clay-bed, which in other parts of

the bajir is perhaps buried under æolian dust, to become exposed. Thus the cause is the same as that which occasions the greatest depth of the desert lakes to be at their southern end, and near their eastern shore.

On this day again the wind blew hard from the north-north-east, and the atmosphere was laden to an almost incredible extent with dust, blotting out every feature of the landscape. Owing to this we got astray and penetrated amongst the high sand; though we were not long before we discovered that we had left the usual threshold on our right, and had climbed up to the top of the gigantic accumulation of sand which towered above it on the east, to the height of 65 to 75 m. Seen from that vantage-point, bajir No. 16 looked like a deep dark chasm, ugly and repellent, its outlines fading away in part into the haze. It was however tolerably small. Except for a chain of low, yellow dunes stretching from its northern end in towards its centre, its level floor consisted of black saliferous ooze, moist up to the very surface, with a ribbon of dry, white salt all round it. We reached the bottom by making the camels glissade down the steep ( $32^{\circ}$ ) dune-slope, but did not venture to advance across the treacherous looking ground until we had reconnoitred it well. As the result of this we preferred to keep to the loose sand which lay along the outside edge of the bajir, for we should have been infallibly lost in the ooze. We did not indeed actually see water anywhere; but, judging from the excessive moisture, the ground-water cannot have been very far down; at any rate it must have been nearer the surface than in bajir No. 8, where we struck it at a depth of 1.20 m., and where the ground was nothing like so moist as it was here in bajir No. 16.

December 25th. Bajirs No. 17, 18, and 19 were all small; they extended north and south, and were separated from one another by low, convenient thresholds, though these did not everywhere consist of continuous sand, but had gaps between the individual dunes. These occasioned us but little inconvenience, and for ten kilometers our march led over perfectly level country; though on both sides we were still shut in by »mountain-ranges» of sand. The only fragment of actual rock that we discovered throughout the entire journey was a fragment of a hard, fine-grained variety, weighing about 10 kg., which we picked up in bajir No. 18. We also discovered proofs that this desolate region is sometimes visited by organic life in the skeleton of a small bird, a couple of recently dead aquatic fowl, and a day-fly, which had been blown astray by the wind. Bajir No. 20 was of moderate size; its floor entirely free from sand, and in appearance as level as the surface of a lake when crumpled by a gentle breeze; the ground, of a dark brown colour, was slightly granulated, somewhat moist, and rather soft. In places we perceived the light downy seed of the kamisch, brought by the wind, and there arrested either by the moisture or by minor irregularities of the ground.

For several days there had not been any appreciable change in the landscape. On the left, for as far as ever we could see, stretched that sheer interminable wall of sand, sometimes jutting out in rounded promontories, sometimes receding in festooning arcs. When, in tolerably clear weather, we gazed eastwards, our eyes were met by series after series of similar steep sandy faces, until finally they died away to a hair-line on the horizon. Each of these bordered a trough or chain of bajirs, all of them parallel to the chain of depressions we were traversing. No matter where we

had started, no matter which of the lakes we had set out from, of those that hang like grapes, each on its stalk, along the right bank of the Tarim, we should still have found a string of bajirs to travel through. In fact the direction in which we were actually travelling was the only practicable route. Had we chosen to cross the desert in the opposite direction, we should have had an excessively toilsome march, because the steep leeward faces of the sandy thresholds would then have been against us, for, as I have more than once said, they all looked towards the south-south-west. It would indeed have been possible to travel westwards, but the difficulties would have been immense, for at each dune-accumulation we should have been forced to climb up 70 to 90 meters of sand, and the only help the bajirs would have been to us would have been when we crossed over them from side to side. To travel eastwards would under any circumstances have been practically impossible, and with camels quite out of the question.

Our day's march was greatly impeded by a strong southerly gale, which blew right in our teeth, and loaded the air with the dust and sand which it whirled up. Every dune-summit was crowned by upstanding »plumes» of sand, and the sharp edges of the steep faces which looked southwards were being planed down visibly before our eyes by the levelling power of the wind. The sand penetrated everywhere, even inside our clothes to the naked skin, and when we closed our teeth, it gritted between them. The north-south dunes running over the thresholds had both their eastern and their western slopes steep, and when such was the case we had to march along the crest, where the sand was to some extent hard. In the troughs between the sand-waves it was much too soft to bear the weight of the camels. All the same we frequently had to have recourse to our spades to make the road at all practicable.

Upon reaching the end of bajir No. 20, we discovered that it was bordered on the south by exceptionally high sand. This seemed to bode us no good. However we perceived two saddles or notches in the sand, the one on the left high and difficult, the one on the right somewhat lower and with a gentle ascent. Accordingly we chose the latter. On reaching the top we saw to the west-north-west a little naked bajir, and behind it a bigger one; but the bajir which lay directly ahead of us was completely choked with sand. Accordingly, at the risk of being taken too far to the left, we decided to keep on the top of the dunes themselves. We then had on our left a small oval-shaped bajir, free from sand, its relief being plainly and distinctly indicated by the series of concentric belts running round it, each indicating a different degree of moisture and each, though in diminishing ratio, reproducing the shape and outline of the bajir itself. Near its eastern edge they were crowded together, but on the opposite side they were separated by wide intervals, just like the isobaths in the lakes we sounded beside the river. The colour too varied from ring to ring, being lightest on the outside, while the ground inclosed by the innermost one was dark brown. This succession of belts or rings was exactly such as would be left by a temporary lake which had gradually dried up. I had observed similar belts around the Tschöl-köl, and had noticed them also in those desert lakes which are cut off from connection with the river. Had these belts been caused by heavy rains, we should have expected to find them in every bajir, or at all events

in the boundary ones; but as a matter of fact they were absent from the most of them. I have never experienced a violent rain in this desert, and in fact it is shut in on all sides by lofty chains of mountains; still that is no proof that it never does rain there, for it can indeed rain, even though it be only once in ten or twenty years. On the other hand, I have twice seen it rain quite briskly at Karakoschun, in 1896 and again in 1900, on both occasions early in the summer. But that snow falls in the desert we were very soon to have a convincing proof. It appears therefore likely, that the desiccation belts to which I have called attention are probably caused by chance rains. The reason they do not occur in the neighbouring bajirs may be because these latter lie at a higher level, whereas the little, oval-shaped bajir being deeper, the surface moisture in it evaporates more slowly owing to the nearer proximity of the ground-water underneath. The dust which settles in this bajir after rain adheres to the moist ground, and in no wise affects the colouring of the different belts; whereas in the adjacent bajirs, where the surface is dry, the dust forms an even coating of uniform colour throughout.

The most noticeable characteristics in the contour of these bajirs are the steep wall of sand on the east, and the leeward southern face, often equally steep, though not so high, of the thresholds. On the other hand, the sandy slopes on the west of the bajirs and on the north side of the thresholds have a much gentler ascent, and consequently the contour of the base of the sand is here rather irregular.

In a bajir such as No. 20 one is amazed to find no trace of sand in its interior. It is entirely surrounded in every direction by veritable mountains of sand, and I was also witness of strong gales from the south-south-west and the north-north-east, and especially in spring and summer of violent gales from the east and east-north-east; yet not one grain of sand is wafted out upon its slightly granulated surface — *schor*. It is as though it were entirely tabu to, and fenced against, all such encroachments. On the other hand, in one place we found some gypsum. The ground, in the bajir in question, was so hard that we were able to travel along the part of it which corresponded to the softest part in all the preceding bajirs. In the sand there is, as it were, a certain power of cohesion or attraction, whereby this »viscous» material holds tenaciously together. As an actual fact, the cohesiveness must really be attributed to the winds, and to the extremely regular deviation which they are forced to make when they blow close to the surface of the earth, as well as to the gradually modelled relief of the desert; hence all that the sand has to do is to follow along the routes which are in this way prescribed for it.

The threshold at the southern extremity of bajir No. 20 is unlike its predecessors, and this, as I have already stated, led to our losing our way in the high sand. Although there were small depressions to both the east and the west, there were none along the route we were following. The leeward flank of the eastern dune-wall appeared to be broken. Accordingly we pursued our way at haphazard, taking no notice of the depressions, trusting that, sooner or later, we should hit upon a fresh chain of bajirs. But this did not happen until after we had travelled 4 km. through the heavy sand, and even then the hollow in which we encamped bore little resemblance to a typical bajir, for it was choked with sand.

On the 26th December the wind still continued to blow out of the south-south-west, and the atmosphere was thick with dust. The sand-dunes still continued to be high, though not so high as they were close to the Tarim. The bajir depressions now began to decrease sensibly in size, and although in the course of a march of close upon 22 km. we traversed eight of them, they profited us but little, for the greater part of the time we were travelling over heavy sand. In fact they were a hindrance rather than a help, owing to our having continually to descend into them and then climb up out of them again at the other end. In several of the bajirs we traversed to-day the desiccation rings were plainly indicated, whether they were due to rain or to the proximity of the ground-water. But the former cause grew increasingly more likely in proportion as we advanced, for with every step we were drawing nearer to the Kwen-lun mountains; and the rains which fall there do reach a good long way out into the desert. The desiccation rings were especially plainly marked in bajirs Nos. 22, 24, and 28. The last-named was of an unusual shape, in that two »bays» were thrust out from the main body of the bajir, one to the south, the other to the south-east. Judging by the desiccation belts, the latter »bay» was the deeper. Between them lay an accumulation of sand resembling in appearance the peninsula in the Ullugh-köl. Strictly speaking, there were two depressions, parted by a broken dune-accumulation. In bajir No. 22 there was but little of the bare soil left; in fact its two thresholds appeared likely to meet ere long, when of course the bajir will totally disappear. In the northern part of bajir No. 23 there were several small level patches, entirely surrounded by low dunes. Between bajirs No. 23 and No. 24 there had been another bajir, now so filled with sand that we were unable to make out its boundaries, the sand being for a long distance uninterrupted. The northern part of bajir No. 25 was filled with small ridges of sand, stretching from north-east to south-west; it was quite patent to the eyesight, that this bajir was deepest in the south. No. 27 was a miniature bajir, or rather three small level patches which we did not think it worth while to go down into.

Thus during the course of the day the going had grown appreciably worse; the sand was obviously getting the upper hand of the level ground. Although we still had the steep wall of sand on our left, and its architecture was still unchanged, the trough or interminable sandy valley we were following was now more directly inclined to the south. At the beginning of the journey it pointed to the south-west; now however it pointed to the south-south-west and even for short distances to the south. The slopes up to the crests of the thresholds were gentle, an angle of  $4^{\circ}$  to  $5^{\circ}$ , but the individual dunes which crowned them were generally disposed from north-north-east to south-south-west. These appeared to be chiefly affected by the east wind, whereas the lowest part of the thresholds, stretching northwards, were most exposed to the effects of the north-north-east wind; hence the capping dunes of the thresholds lay crosswise, from east to west. But the descent on the other side was one unbroken slope to the south-south-west.

One great difference between this desert and the Takla-makan is, that in the latter the patches of bare ground are not only excessively rare, but occur in a most irregular way. It is true that the dune-accumulations are also dome-shaped in the Takla-makan, but they melt more into one another, and are subject to less regular

and constant winds than are the deserts that lie farther to the east. There are no bajirs there, neither in the Chotan-darja nor in the Kerija-darja. It is only here, in the east, that the dune-waves possess broken or »breaking» crests; farther west their summits are more rounded. Probably these latter are not affected by the east wind, at all events it does not blow there with the same violence and regularity as in the Lop country and the Desert of Tschertschen. Lower down I shall have occasion to institute an organic comparison between these different deserts.

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## CHAPTER XXI.

### BAJIRS WITH KAMISCH — DESERT SNOWS.

On 27th December we were favoured with a beautiful, bright sunrise, a pure sky, and a quiet atmosphere, but the sun had not got many degrees above the horizon when it disappeared, and the sky was veiled with thick black clouds, this time real rain-clouds, not clouds of drifting dust. Having traversed bajir No. 29, in which the desiccation-belts were distinctly perceptible, we found ourselves face to face with a high and very difficult sandy pass. From its summit we had an extensive view over No. 30; and some of the features it presented were unusual. Its floor was dotted all over with detached dunes, scarce a meter high, and in amongst them were scattered small black clumps of dead and withered kamisch. In addition to that, there was also living kamisch, growing on its own roots, on the low sand; this was most abundant in the southern end of the bajir, where the ground-water, as usual, came nearest to the surface. Here too were hares and small burrowing rats, and we also observed two or three small birds, though not a single trace of antelopes or wild camel. The next bajir presented precisely the same features, and there we halted for the sake of the scanty grazing it afforded.

This discovery was in the highest degree unexpected. Since leaving the Tarim we had travelled 125.4 km., and still had rather more than the same distance to go to reach the Tschertschen-darja. Thus we had discovered in the very heart of the desert two expanses of level ground provided with still living kamisch, although yellow and dry, as it usually is in winter. Still there were a few patches, in especially well sheltered situations, which had not yet entirely lost the green tinge of summer. Why now did these sheltered oases still survive in these little bajir depressions? In the first place, it is perfectly self-evident that the ground-water was quite close to the surface, for without it the reeds would be unable to live; here then it was sufficiently near for their roots to reach it. In none of the preceding bajirs had we found so much as a single stalk of kamisch, although, as I have mentioned, we did observe in one of them its fine flosky seed-down, no doubt blown thither by the south-south-west wind. Bajir No. 29 was just as barren as all its forerunners, and yet it

was separated from No. 30 by a sandy isthmus only 1,200 m. across. All the same this narrow dividing-line formed the boundary between the barren parts of the desert and the beginnings of vegetation. And for several successive days we travelled through similar bajirs, a whole series of them, and then once more we plunged into the blank desert. Although the vegetation was niggardly, nevertheless at the first glance I concluded we had struck the region which in former times was reached by the extreme tentacles of the Kara-muran; for in the locality where the Kerija-darja becomes finally lost in the sand I had discovered a not very poor vegetation. At the present day the Kara-muran is a small stream, and it will soon die out altogether; but it is quite certain, that in former times it was bigger, in fact, it may once have flowed all the way to the Tarim, in the same way as the Chotan-darja does now. If that was the case, it must have described a decided curve towards the north-east, and this opinion derives strong confirmation from a comparison with its neighbours, the Chotan-darja, the Kerija-darja, and the Tschertschen-darja. If we assume that the Kara-muran bisected the space between the Kerija-darja and the Tschertschen-darja, it would have flowed approximately through that part of the desert in which we then were. I inferred therefore, that if we continued to follow the same direction as heretofore, the vegetation would soon cease. And this indeed proved to be the case.

But the presence of this vegetation admits of explanation even without the Kara-muran. It is evidently so long since the river retired, that there has been time for one or more »sand-waves» to cover, and so stifle, the last remnants of vegetation that still survived alongside its bed. Hence further reflection has led me to the opinion, that the kamisch we saw has nothing whatever to do with the river in question. All the conditions requisite for its origination and perpetuation are indeed present without it. The soil, a mixture of fine dust and sand, is precisely such as kamisch thrives best in, and then the ground-water is not very far down. The only question that remains is, how the reeds could find their way thither across the mountains of sand. And yet the explanation is quite simple, after the flocks of reed-down which we encountered in an earlier bajir. The agency of its dissemination is the wind, either the powerful east-north-east or the south-south-west wind, blowing from the prolific and extensive reed-beds beside the Tschertschen-darja. The absence of vegetation in the bajirs previous to and including No. 29 may be due to the amount of saline impregnation in them being too great for any vegetation to thrive; otherwise some of the drifting reed-down must surely have struck root, at all events in bajir No. 29, if in no others. It will be remembered that the water in the well we dug was nothing more nor less than a concentrated salt solution. Farther on we shall find that the wells yielded water that was virtually fresh. And in fact the experience of my former journeys goes to show that the farther you advance from a river the greater becomes the likelihood of finding fresh water.

In the bajirs in which we found kamisch, the arrangement of the sand was so far different that the small dunes were distributed pretty evenly over their entire area, and there were no desiccation belts discernible. Thus, however thin and scanty the vegetation, it seems to possess the power of arresting the sand, and of holding it together in the usual small accumulations on its sheltered side, where they grow bigger as time goes on. The dust which falls there must also be relatively more

stationary than that which falls in the barren depressions. However the vegetation does not give us any information as to the velocity with which the sand-waves move. Owing to the insignificant role which it plays in this respect, it may be left out of account altogether, for it is much too thin and starved to check the windward flank of the dune-wave in its progress westwards: the utmost it can do, supposing it to be sufficiently dense at any spot, is to retard a little one or the other promontories or spurs of the main mass. So far as I observed, the *kamisch* grows only on the level floor of the *bajirs*. It does not grow amongst the lowest dunes on the windward side of the dune-accumulations; no doubt the ground-water is there too far from the surface. On the east side of the *bajirs* such vegetation as exists is smothered by the advance of the steep leeward flank and by the avalanches of sand which pour down over it. The westward advance of the dune-waves, and consequently also of the *bajir* depressions, takes place much more slowly than the vegetation is able to spread itself over the floor of the *bajir*. Though strip after strip is thus overwhelmed by the sand, fresh strips are at the same time set free from the superincumbent sand on the west, so that in its outward appearance the *bajir* really suffers no essential change. In fact, the depression itself travels westwards, and as it advances, its soil, and the vegetation which may chance to cover the same, are steadily renewed as time goes on.

On the 28th December, after the thermometer had dropped to  $-21^{\circ}$  C. during the night, there was a violent wind from the east, apparently an unusual quarter for it to come from at this season of the year. The sky was clouded, and the atmosphere full of dust and sand, and we never once caught a glimpse of the sun. The wind continued all the morning, and in fact all day. Owing to the thickness of the atmosphere it is easy to deceive yourself as to distance. You fancy that the *bajir* you are dipping down into is long, and looks promising; but before you have gone very far along it you see the southern threshold looming out through the haze. The masses of sand immediately in front of you look like distant mountain-chains and the pyramidal dunes like gigantic mountain-peaks, and yet they are in reality quite close at hand. I do not know whether the weather in this desert is always what it was that winter, but to us it was in the highest degree repugnant, and weighed oppressively upon our senses. Do what we would, and in very despite of the sure knowledge that we were only so and so many miles from the edge of the desert, a feeling of strange uneasiness would keep creeping over us, and we kept fancying we were being led hopelessly astray deeper and deeper into the heart of that most inhospitable region. Our spirits were depressed by the continuous twilight which prevailed; it was as though we were travelling in a region which the sun's rays never reach, as though we were travelling through the wintry landscape of the eternal shades.

After traversing the rest of *bajir* No. 31 we again entered upon the heavy sand, leaving on our left a small fragmentary *bajir*. The next *bajir* in our course, No. 32, was exactly like its predecessors, neither better nor worse. Towards its northern end it had two or three small dunes, towards its southern a short stretch of level, but barren, soil, while everywhere else it was clothed with sparse fields of *kamisch*. The immediately following threshold was very difficult, and long, and it took us a considerable time to climb to the top of it. The individual dunes of which



it was built up rose at an angle of  $4^{\circ}$  from the north-east and plunged down steeply towards the south-west. The higher these individual dunes are situated on the threshold, the steeper are their windward slopes. The long leeward slope which went down from the last of these dunes descended at an angle of  $32^{\circ}$  to  $33^{\circ}$ .



Fig. 269. INDIVIDUAL DUNE-RANGES UPON THE HIGHEST PART OF A DUNE-ACCUMULATION.

Bajir No. 33 fully realized all that we expected of it: its southern end was lost in the grey tints of the far distance, and its floor was covered with a more abundant crop of kamisch than any of the bajirs we had hitherto traversed. We found in it one solitary tamarisk, bravely struggling against destruction, though it was entirely dead except a few branches. Several of its other branches, dry and withered, lay scattered around it. In all probability only two or three of its root-fibres now reached down to the ground-water. In places the kamisch still showed tints of light green. For the most part it was dead and withered, broken, dark-coloured, and only one or two decimeters high, as though it had been eaten off. It had however been broken and destroyed after it withered. It is this surviving stubble which makes the ground appear chequered with black spots. This kamisch is always found growing in conjunction with small rudimentary dunes; it does not grow where the ground is free from sand. The reason of this is no doubt that to which I have already pointed: it is the kamisch which starts the formation of the small dunes on its own sheltered side.

Continuing our journey on the 29th December, we traversed bajir No. 33, the longest and biggest throughout the whole journey. This, in contrast with those at the beginning of our march, lay due north and south. In length it measured not less than 19.5 km., and, shut in as it was by the long sand-waves, it was like a glen or dried-up river-bed. Every now and again the prospect ahead was hidden by headlands (*tumschuk*) projecting from the western sand, but no sooner were we past each of these in turn than the bajir opened out again. As far as the dust-haze would permit us to see, the steep dune-wall continued to fence in our route on the left, though in one place, towards the southern end of the bajir, there was apparently a breach in it, occasioned by one wing of the dunes having advanced faster than its neighbour. The floor of the bajir was almost everywhere covered by low spoon-shaped dunes (fig. 270), elongated (fig. 271) from north-east to south-west, and amongst and round about these the kamisch was still growing, although more sparsely than hitherto. But in



Fig. 270. SPOON-SHAPED DUNE.

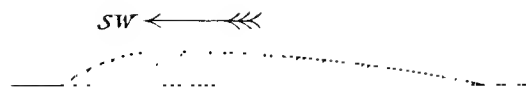


Fig. 271. VERTICAL SECTION OF SAME.

the southern part of the bajir there appeared a number of other steppe plants, especially *tschige* and tamarisks, these last, both living and dead, being particularly plentiful, and growing in some places on pretty lofty

mounds. These last indicate that the bushes whose roots ramify through them like a skeleton have attained a certain age, for it is plain, that it is the tamarisk-bush which gives rise to the mound, and not the mound which originates the bush. We noticed here too, that the tamarisks which were growing farthest to the east had the biggest mounds; in fact those in the west possessed no mounds. The situation is illustrated in fig. 272. The bajir is travelling in the direction indicated by the arrow. The tamarisk *a* has struck root in the part of the bajir which has just been freed from sand. Tamarisk *b* has been free from sand and exposed to the wind for a longer period, and consequently it possesses a low base or pedestal. Tamarisk *c* has been exposed to the play of the winds for the longest time of all, and its mound or cone is consequently the highest. The linear vertical portion shows that part of the original floor of the bajir which has been excavated and blown away by

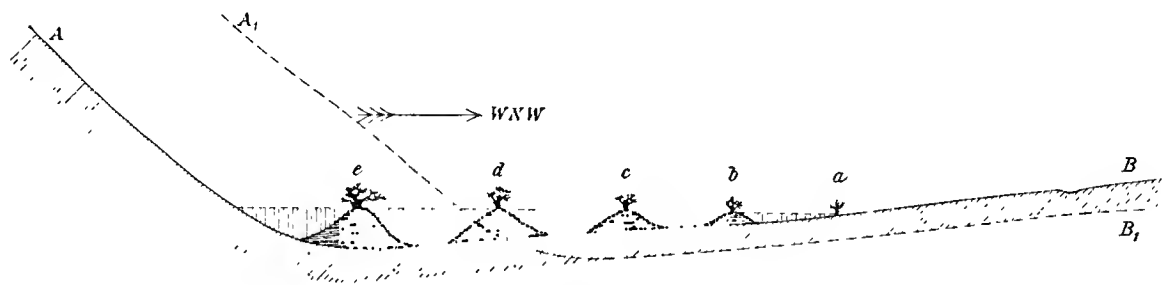


Fig. 272.

the wind; while the horizontal shading indicates the only portions that still survive, namely the mounds or cones held together by the roots of the tamarisks. When the bajir and its attendant dune-waves have travelled from AB to A<sub>1</sub> B<sub>1</sub>, the mound *e* will be buried under the advancing sand of the leeward side of the dune-wall. Here too we observed other evidences of organic life, of hares and foxes, and we actually saw a big wolf which fled away westwards. This favourable bajir terminated in a sort of *cul-de-sac*, being surrounded on all sides except the north, from which we had come, by high sand. There we halted for the purpose of digging a well, for it was evident the ground-water could not be very far down. The surface was frozen as hard as a stone to the depth of 18 cm., which was indeed a good sign, for in previous cases in which the *schor* had not been frozen the water was salt. We struck water at a depth of 1.38 m.; it had a temperature of 8°.2 C., and was perfectly fresh and drinkable. It trickled out very slowly, and principally from the southern face of the well. Here again I found additional confirmation of my observation, that the farther we advanced from the river towards the interior of the desert, the better became the water. I have also observed the same thing in various other parts of the desert, but can offer no explanation of why it should be so.

That we here, in the heart of this hateful desert, should thus light upon all the necessities of travel that a caravan requires, can only be described as in the highest degree strange and amazing — namely, kamisch, grazing, fuel, and fresh water, and also, had our provisions given out, roast hare! When I started from Jangi-köl, I never even dreamed of such a thing. Possibly, as is indicated on an older edition of the map of Central Asia by the Russian general staff, anciently a road did run diagonally through the desert from Tattran to Korla, for that route cannot have been inserted by mere chance.\* Yet the people who live both north and south of the desert have no knowledge, or even any tradition, that there once existed any such line of communication, and even if there did exist some such route in the days of dim antiquity, it can only have followed the direction we were travelling in, for, as I have already said, it is impossible to journey from south to north because of the steep thresholds or isthmuses of sand that separate the bajirs one from another.

All day long the wind blew from the east-north-east, and in the evening there was not a single star visible. A winter's night, such as that which followed, without moonshine, without starlight, is indeed a thick darkness that may be felt.

Beside the well we had dug we indulged ourselves and the camels with a day's rest, and during it the wind blew hard from the east. Having no tents, we sought shelter under the steep dune-slope on the east, and as all our effects lay out in the open, I was able to observe the gradual approach of the drift-sand towards them, and it was not long before they were covered with a thin coating of sand. It was however only close to the earth that the wind blew from this direction, for heavy clouds were driving with great velocity from west to east, or in exactly the opposite direction. The water continued to trickle out into our well all night, and in the morning was encrusted with a thin sheet of ice; and not only the sides of the well, but also the sand which was thrown out of it, were alike frozen as hard as a stone. This last was only to a slight extent intermingled with clayey matter; whereas in the wells we dug in the more northerly bajirs the fine saliferous matter predominated and the proportion of sand was quite small. The water in these wells rests upon a layer of clay, and when you have dug down to that, it begins to trickle out from the lowest layer of sand. Both nights that we spent in this spot our camp was visited by a fox, which approached quite close to us. Strange that this creature, as well as the wolf, should advance so far into the desert where there is no water. No doubt it is the hares that tempt them, for next day whilst on the march we saw numbers of these animals; they appeared able to subsist without water. Another very common animal is a species of small rodent, a kind of earth-rat,

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\* The particular sheet of this map which lies before me as I write, namely that for the eastern half of East Turkestan, possesses neither title nor date, but it appears to have been published in 1878 or later, for it shows the discoveries made by Przhevalskij on his first journey to the Lop-nor region. The route in question follows an almost straight line from Korla to Tschertschen, and consequently crosses the Ugen-darja and the Tarim above Karaul, and then passes by the »well of Tartang« about 50 versts north of Tschertschen. Tartang is of course identical with Tattran. Wherever the Russian topographers may have derived their information from with regard to this mysterious route, leading diagonally across the desert, it is at any rate a matter of great interest, and it is not at all unlikely that in former times the desert was crossed along some such line.

called by the natives *sägisghan*. But of antelopes or the wild camel we did not perceive a single sign.

After a perfectly clear night, during which the stars shone out, though faintly, the morning of the 31st Dec. was quite as cloudy and quite as disagreeable as it had been before, and the wind was still blowing from the same quarter. Bright nights followed by cloudy days, with thick dust-haze, — such seemed to be the rule. The natural consequence of such an alternating sequence is to chill the surface of the earth. There is nothing to prevent radiation during the night, while there is everything to prevent insolation during the day. The only way to keep our spirits up was to walk.

Although more than half of the day's march was through sand, we nevertheless covered 24.3 km., but the sand was low, and did not force us to make any great deviations whereby time is wasted. Crossing the first sandy isthmus we found ourselves in bajir No. 34; it was quite small, and contained some tamarisks. But we nowhere found these bushes so plentiful as they had been at Camp No. X. Bajir No. 35 was all the greater, and lay exactly along the line of our route. Here, in addition to the ordinary kamisch, tschige, and tamarisks, another steppe-plant occurred in great abundance; it is called by the natives *äschäk-kamutsch*. At the south-south-west end of this bajir we reached. after a long climb, the top of the dividing sandy isthmus, and then saw on our left a fresh bajir, which, contrary to the rule, extended to the south-south-east for as far as we were able to see through the blurred atmosphere. We had encountered the rudimentary beginnings of a similar irregular arrangement of the sand in bajir No. 28. This departure from the normal produced also an interruption in the long steep sandy wall which had hitherto accompanied us on the left. But although it too inclined to the south-south-east, it was in all probability for a short distance only. The steep dune-wall which shut in bajir No. 37 on the east and north-east belonged thus to a fresh chain of dunes, which here thinned out, as it were. The bajirs still continued to be distinctly perceptible, and still preserved their usual shape; but the irregularities which now began to appear seemed to indicate, that we were approaching localities in which the prevailing winds are less regular than they had been hitherto. As I have already mentioned, owing to the feverish haste with which we marched, and to the weariness which we consequently felt, I was unable to take any precise observations of the height of the dunes; but I think I may trust my own eyesight, and may affirm that they decreased in altitude, though at a very slight rate, in proportion as we advanced southwards. The masses of sand were neither so gigantic nor so imposing here as they are beside the Tarim.

As for bajir No. 36, running with its chain of dunes towards the south-south-east, — if one were to regard the prevailing winds alone, one would be tempted to say, that every chain of dunes and every string of depressions in that desert *must* necessarily stretch from north-north-west to south-south-east, for it is from the east-north-east and the north-east that the prevailing winds come. But instead of the dunes lying in this way at right angles to the direction of the wind, the latter strikes them at an acute angle; the only bajirs in which it strikes them at right angles are Nos. 28 and 36. But I shall have something more to say on this topic later on.

We were tempted to follow bajir No. 36, for without doubt it would have given us a good help along our road; but, as it did not run in our direction, we left it alone, and turned our steps up into the sand, and were soon rewarded by finding bajir No. 37, which not only ran in the direction we wanted to go, but was pretty large. It gave the impression of an elongated arena fenced in by high sand, and the threshold at its south-south-west extremity appeared to be unusually low in elevation. In respect of its vegetation this bajir was like those we had just traversed, but its western half was filled with small dunes, which increased in size the farther west they were situated, until finally they became merged in the windward flank of the fresh chain of dunes which started there. But the eastern half of the bajir was perfectly free from sand, and it was there that the vegetation had especially got a good foothold. True, there was sand amongst the bushes, but there were no dunes. Thus in bajir No. 37 there was no clay soil exposed, not even so much as one square meter. Consequently from bajir No. 30 inclusive the ground consisted of sand, and yielded vegetation, and the ground-water was fresh; whereas in all the bajirs before No. 30 the ground had consisted of saliferous clay (*schor*), was devoid of vegetation, and yielded water that was salt. Certain enterprising scrubby plants had actually established themselves on the lower slopes of the steep eastern wall, even as high as 10 to 15 m. above the floor of the bajir. Now though this indicates a very slow advance on the part of the dune-wall, it does not by any means mean that the latter stands still, for these plants, which love to have their roots amongst the sand, possess, like the saksaul, the ability to »swim», as it were, on its surface; and even when a part of the plant becomes buried under the sand, a new shoot springs up, and the roots are lengthened. They are, as it were, the water-lilies of this sandy ocean, and float on its waves. Yet many no doubt perish in it all the same.

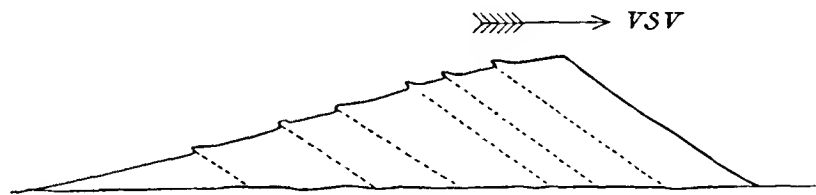


Fig. 273.

Here too another structural formation began to appear. It is shown in section in the above illustration (fig. 273), and consists of a series of ridges or swellings, in most cases very narrow and not more than one or two centimeters in height, which stick out on the windward side of the individual dunes, that turn their steep leeward side towards the west-south-west, and form as it were a sort of ribbing on it parallel to the existing crest. It soon became apparent that they had previously each in turn been the actual crest of the dune. A closer investigation showed that the sand of which they are composed is closely packed together, and is hard and cohesive, so that small fragments can be chipped off it, though it requires but little force to make them crumble to pieces again. Still their cohesiveness is sufficient to prevent the individual particles of sand from falling asunder, as they do elsewhere. What prevents them from

rising more than one or two centimeters above the face of the dune is the powerful corrasion to which they are exposed, for just where they project the attrition and scouring of the drift-sand are exercised with the greatest degree of energy. Upon digging into the dune beside them, we ascertained that each was merely the edge of a lamina, which permeates the dune throughout parallel to its steep leeward face. The fact that these laminæ persist through the interior of the dune, and come to light again on its windward face is an irrefragable proof, that the dunes in which they exist do travel towards the west-south-west, as indeed one would necessarily expect from the direction of the prevailing wind. The fact that the big accumulations of dunes turn their steep faces towards the west-north-west is therefore to be accounted for by other causes; the individual dunes are at any rate directly subject to the winds, and turn their leeward sides to the west-south-west. The laminæ of which I have just spoken bear witness also to the presence of precipitation, whether rain or snow, for it is unlikely that they owe their origin to the dew. Once or twice only, and then it was in the vicinity of the Tarim, did I observe rime-frost of a morning, the dunes on one occasion being almost white with it; but in the interior of the desert, where the atmosphere is very dry, I never once detected the presence of dew. And even though these laminæ were caused by dew, one would expect to find both the projecting ribs and the laminæ themselves not only lying closer together, but thinner, and they ought to have decreased in number from north to south, instead of first making their appearance, as they do, in the southern half of the desert. Their occurrence is indeed quite sufficiently accounted for by the falls of snow which we subsequently witnessed. When the snow melts, the steep slopes become wet. The dust which then falls adheres to the moist surface, and so serves as a cement or binding material to hold the particles of sand together. Moreover the sand itself contains other fine particles which, owing to the moisture, develop a greater attraction for the sand particles themselves. The intervals between these projecting ribs vary of course a good deal, but they are seldom less than one meter, and frequently amount to several meters. Hence there cannot be a doubt as to the mode of their origination; but as for the other phenomena connected with them, I regret to say I am not in a position to offer precise data. If we knew what was the amount, and so forth, of the precipitation, we should be able to calculate the rate at which the individual dunes travel, or if we were in possession of this last-mentioned datum, we should be in a position to make deductions as to the frequency of the snow-fall and rain-fall. But we are ignorant of both. And it is equally impossible to determine how far the harder laminæ are produced by rain or by snow, or by both acting alternately. But a theoretical and continuous section of the dune, extending over several years, would, I feel sure, show that these harder strata recur at tolerably regular

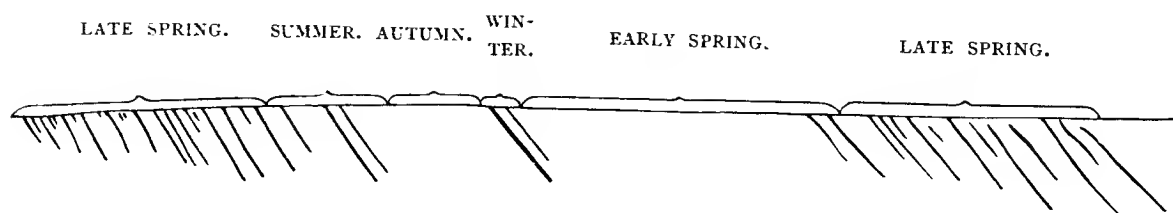


Fig. 274.

intervals. They would occur most frequently in the spring and early summer, that being the rainy season, when the storms are frequent, and the rain-wetted surface is covered by the sand which is blown over upon it; if this were not so, the different strata would not be distinguishable from one another. The summer would probably show one, possibly two, thin laminæ, of very moderate extent, and the winter one thick lamina, or two laminæ less thick, likewise of very moderate extent; whereas the beginning of spring, the windy season *par excellence*, would be represented by a large extent without any harder lamina, though the latter part of the spring would yield several of these, equal in number to the frequency of the precipitation, and likewise reaching over a large extent. In saying that the winter would produce only one lamina of harder consistency, I have also in mind the experience which I had in the winter of 1899—1900, and which fully bears out this theoretical conclusion. At that time the snow, renewed as it was by frequent showers, remained on the ground for a long time, and occasioned a complete cessation of the general advance of the sand-dunes, even when the wind blew. But whenever the interval between two falls of snow is sufficiently long for the first fall to disappear entirely before the second comes, and a strong wind then sets in, we in that way get two strata of harder consistency.

But as in the meantime (fig. 275) a sheet of snow covers both the north-east and the south-west slopes of each individual dune, when it melts on the former face it ought to produce a harder lamina of the same kind as that on the south-west slope, where we have the ribbing I have spoken of. The harder surface on the north-east face ought also to prevent the wind from sweeping away the sand which lies there; and possibly it does do so to some extent, so that the movement of the dune is checked, be it ever so slightly. But, as I ascertained, there is a great difference in this respect between the windward and the leeward faces. For after a copious fall of snow, sufficient to enshroud the dunes entirely, and fine weather then followed with sunshine, I noticed how quickly the snow melted on the slopes which were directly exposed to the sun, making the sand moist, whereas on the opposite or north-east slope it continued to lie a long time. As we gazed south-west, the entire desert appeared to be white; but when we turned our eyes to the north-east, we could see no snow except a few thin strips. Hence the difference between the two slopes is this, that while the snow melts on the south-west face, on the north-east face it evaporates, without to any appreciable extent moistening the sand. And even though the latter does in any degree cement together, it is soon softened again by the conjoint action of deflation and corrasion.

The threshold between bajirs No. 37 and No. 38 was exceptionally low and modest; its individual dunes were not even connected together, but were separated by small patches of level ground, studded with dead tamarisks on their conical mounds.

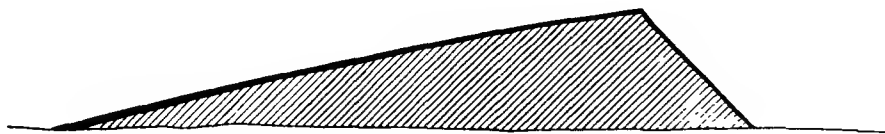


Fig. 275. THE BLACK IS A LAYER OF SNOW.



Fig. 276. ON THE TOP OF A HIGH THRESHOLD WITH A THIN COVERING OF SNOW.

On the 1st January 1900 bajir No. 38 proved less serviceable to us than its predecessors, for its floor was in great part studded with small dunes, difficult to travel amongst; its vegetation was much more scanty, and the dune-masses which surrounded it were unmistakably lower. Traces of the two rodents I have alluded to were quite common. The threshold at the southern end of the bajir turned out extremely deceptive. We made of course for its lowest saddle; but this, instead of soon coming to an end, continued to ascend higher and higher, and gradually passed over into a labyrinth of large, but perfectly barren, dunes, amongst which there was

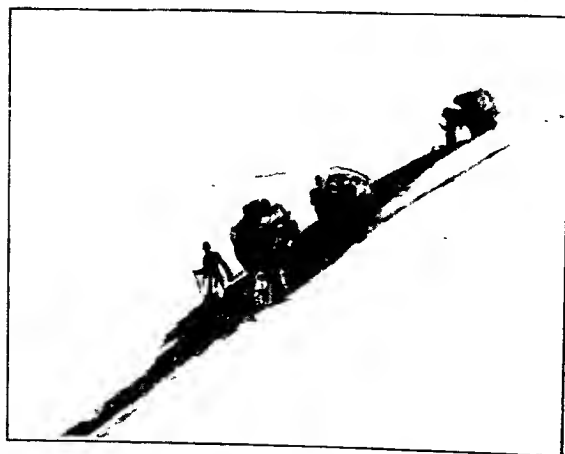


Fig. 277. GOING DOWN THE LEE SIDE OF A HIGH, SNOW-COVERED THRESHOLD.

but a solitary tamarisk or two to be seen. Climbing to the top of a high dune, we looked, but looked in vain, for the next bajir; the bajirs seemed now definitely to have come to an end. We had a free sweep for a long distance to the south, where the dunes appeared to be all of the same height; the gigantic dune-walls on the left were no longer present; the desert architecture seemed all of a sudden to have changed. Fortunately the dunes still lay favourable for us, from north-north-west to south-south-east, and turned their steep faces towards the west-south-west.



But we failed to detect any signs of a fresh bajir; though the steep sandy walls which a long way off in the east faced towards us proved that there were bajirs there. The tamarisks, being more widely scattered, looked like black dots on the unending expanse of yellow sand. Finding, in a valley between two high dunes, a few living tamarisks, and some kamisch that was tenderer and fuller of sap than any we had hitherto come across, we decided to encamp. Throughout the whole of this desert journey, we did not see a single trace of a poplar; not even an ancient trunk rewarded our search, although I did discover one a pretty long way in the Desert of Takla-makan. It was not until we reached the extreme south of the desert that we found dead poplar-trunks.

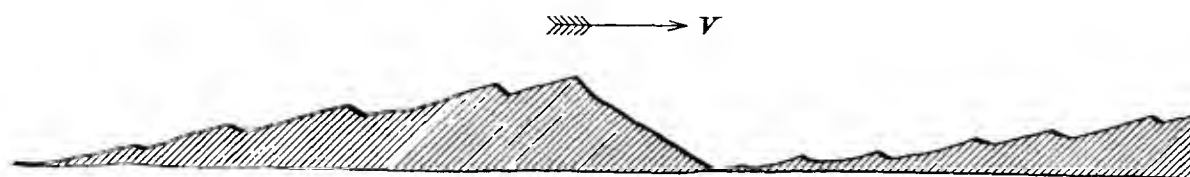


Fig. 278. VERTICAL SECTION OF A SANDED-UP BAJIR FROM EAST TO WEST.

The peculiarity of the belt of desert in which we now were was that the dunes were no longer piled up in gigantic ranges or chains, but were more individually separate and more uniform in elevation. It was only occasionally that a pyramidal dome towered above its neighbours.

On the morning of the 2nd January it was snowing softly, and the ground was buried under a white sheet, through which projected only the reed-stalks that the camels had not plucked off. I had never before seen the dunes shrouded in this funereal garb, but its effect was to enhance still more the bareness and desolation of the desert, and give it the appearance of being sunk in an even deeper and chillier swoon of death than heretofore. The snow did not however consist of the ordinary stelliform flakes, but of needles and crystals of an extremely fine, thin shape, resembling a severe rime-frost. But before noon it had all disappeared off the slopes that faced southwards, and in the afternoon the sand everywhere resumed its usual yellow colour, except in certain sheltered hollows, where a few white strips still clung.



Fig. 279. VERTICAL SECTION OF THE PART OF THE DESERT WHERE THERE ARE NO BAJIR-DEPRESSIONS AT ALL.

Again we lost ourselves amongst the heavy dunes, which indeed appeared to grow bigger as we advanced; and gradually the vegetation came to an end. We failed to strike any fresh bajir. The steep leeward faces of the dunes were all turned towards the south, the west, or the south-west; here it would have been absolutely impossible to advance to the north or to the east. During the day's march I observed that there were accumulations of dunes corresponding to the thresholds

that part the bajirs, the only difference being that the intervening spaces, the depressions, were themselves choked with dunes, so that there was no longer any bare soil to be seen. Of such depressions we crossed five. Slowly we worked our way up to the summit of the crest of each such accumulation, whence the descent to the south was steep and long, as heretofore; thence too, when the atmosphere was clear, we had an extraordinarily extensive view. At 4 o'clock the snow began to come straight down, and blotted out the landscape all round us, making it impossible for us any longer to select the lowest and most convenient saddles; we had simply to march by the compass. The face of the country was again one uniform sheet of white. Towards the south the sky was sometimes clear, but above our heads it loured heavy with black clouds. Close to the surface of the earth there was a fresh south-south-west wind. At length we came across a couple of black and dead tamarisks, growing on mounds; these and the presence of a little kamisch invited us to halt. In spite of the unfavourable going, we had managed to do 21.9 km., and in this stretch there was not one square meter of ground that was free from sand, this being the first day of the journey on which we marched uninterruptedly over sand. Here, although the sand was barely half the height it was beside the Tarim, it was incomparably more difficult to travel over, because the arrangement was no longer what it had been — sharply defined ridges and chains of dunes embracing bajir depressions free from sand. Here again we observed quite recent signs of foxes. It would have been very interesting to have now altered our course, and to have steered straight for the spot where the Kara-muran enters the desert; but the distance was too great, and I considered it more prudent to choose the nearest way to the Tschertschen-darja.



Fig. 280. VERTICAL SECTION OF A SANDED-UP BAJIR FROM NORTH TO SOUTH.

At Camp No. XIII we rested a day in order to dig a well, selecting for this purpose a relatively deep hollow in which some kamisch was growing. We struck the ground-water at a depth of 1.13 m.; its temperature was  $6^{\circ}.9$  C., and although, when compared with the water we obtained from the river-ice, that we carried with us, this had a faintly bitter flavour, it was nevertheless quite drinkable. The ground was frozen to a depth of 33 cm. It snowed all day without interruption, and often very heavily; now the snow was of the usual flocculent character, and fell softly and silently like tiny parachutes, and when the camels trod on it, it crunched under their feet; by evening the sand was covered with a very thick sheet, as loose and soft as cotton. All day long too we were shrouded in a kind of twilight, out of which the soft white flakes came floating towards us from all sides. But it was a lighter, purer, pleasanter haze than that caused by the dust. During the following night the thermometer dropped to a minimum of  $-30^{\circ}.1$  C. It was a peculiarity that winter, that the severest cold was coincident with the snow-fall; possibly the salt which the soil to some extent contains may have been mixed with the snow, and so

caused a lowering of the temperature.\* It went on snowing all night, and in the morning we and our effects were literally buried under it.

On the 4th January it still continued to snow, and even when the sky cleared above-head, it still went on snowing; for the greater part of the day however it was cloudy, and the temperature did not rise above  $-13^{\circ}$  C. The wind blew from the south. Before the day came to an end, the arrangement of the sand once more changed, and the main features of the relief that had previously prevailed once more became evident. Accordingly four bajirs made their appearance, and though they were very narrow, with kaimisch on the east side and low, hard, level sand on the west, they nevertheless afforded us some assistance. These bajirs were formed with perfect regularity, and were fenced on the east by the usual lofty, sharply outlined wall of sand, pointing to the recurrence of the immense accumulations, running north and south, with which we have grown so familiar, and they were parted from one another by perfectly barren thresholds. It was however interesting to note, that these bajirs, in which the level clay was nowhere exposed, but which were in the stage of sanding up, extended towards the south-south-east, not towards the south-south-west as in the northern half of the desert; and this new direction was in far better agreement with the prevailing wind. Except in bajir No. 42, we did not observe any tamarisks. During the day the snow evaporated rapidly,

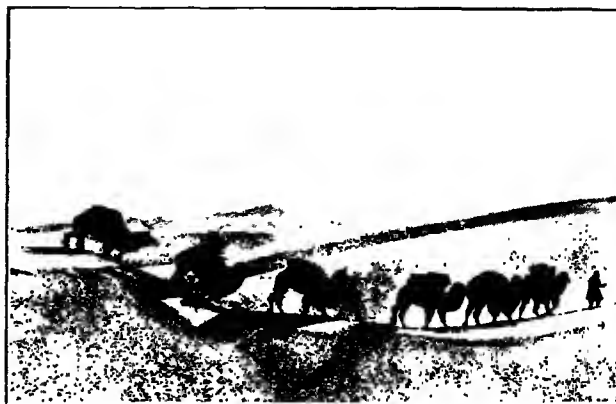


Fig. 281. A PART OF THE DESERT WHERE THERE ARE NO BAJIRS.

and in the afternoon it lay one to two cm. deep in convex places, but about 1 dm. in the hollows; on the slopes facing south it had disappeared entirely.

Again it snowed all night, but cleared up at 9 a. m. on the morning of the 5th January. The temperature did not drop below  $-16^{\circ}$  C. Such wide ranges of temperature are however unusual in the desert in winter. Although apparently the sky was perfectly blue and serene, the fine ice-needles nevertheless still continued to fall, and their facets reflected the sun all day. The snowy mantle was 3 cm. deep, and the glitter from it, when the

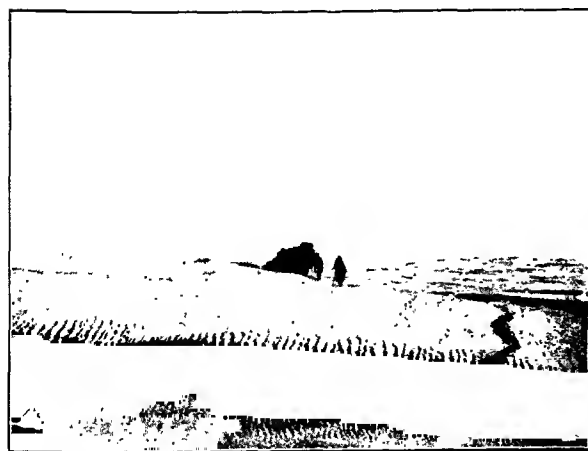


Fig. 282. STEEP LEESIDE FALLING TO THE SOUTH. EFFECT OF THE RIPPLE-MARKS UPON THE MELTING OF THE SNOW.

\* Walther says with regard to this point: »Wenn man weiter erwägt, dass ein Gemisch von Schnee und Salz eine beträchtliche Temperaturerniedrigung herbeiführen kann, so wird bei leichtem Schneefall, wie er in der Wüste gelegentlich beobachtet wird, eine energische Abkühlung von Salzseebecken eintreten.« — *Das Gesetz der Wüstenbildung*, p. 148.



Fig. 283. WALKING DOWN THE SAME SLOPE.

sun shone out, was more than the strongest eyes were able to endure. Desolate and silent though it was, the scene was all the same both majestic and sublime. During the morning, so long as the westward-facing slopes remained in the shade, their tints varied from grey-blue to a cold steel-blue according to the angle at which they lay, while the summits of the dunes glistened white like the backs of dolphins. It would have been easy to imagine one were travelling amongst the eternal snow-fields of the high Alps. But the atmosphere in the distance was an opaque grey, because of the fine crystals with which it was filled, so that we were unable to see distinctly for more than one kilometer away.

To-day the sand was higher and more difficult than on the day before. The small depressions we struck into were completely sanded up, and proved of no real assistance to us on our march; and each was successively poorer in *kamisch*. All day long we passed only two or three tamarisks, growing as usual on high conical mounds, but evidently quite dead and withered a long time ago, so that they were tolerably old, if not indeed very old. Now the dune-waves of the sandy ocean avoid these tamarisk-cones, so that the latter are always surrounded by circular dunes. In fact the cone, with its girdle of dunes, is like the active crater of Vesuvius inside its Monte Somma, a form of relief to be ascribed to what the Germans call *Windstauung*. Nevertheless, whenever this circular dune grows sufficiently high, it must inevitably overwhelm the tamarisk-cone.

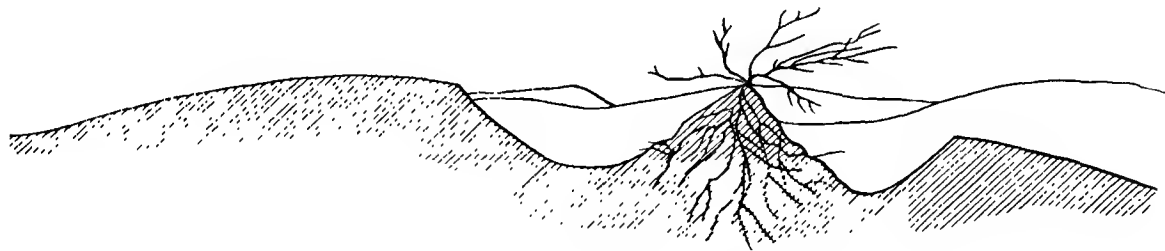


Fig. 284. VERTICAL SECTION OF DUNES AVOIDING A TAMARISK CONE.

Small depressions answering geographically to the *bajirs* still continued to meet us at intervals, but they were all more or less filled with sand. The difference in this respect, as compared with the northern part of the desert, is plainly to be accounted for by the winds, which follow other, and increasingly less regular, directions in proportion as you approach the mountain-chain of the Tokus-davan, and the region in which the montane winds prevail. We had been every way more comfortable in the middle of the desert than we were here. Still the sand was not absolutely and entirely barren. Sometimes we would travel for several hours together without seeing a trace of organic life; then we would perceive a few stalks of ka-

misch sticking out of some dune-glen or other, or a tamarisk-cone would loom into sight. I wonder if this vegetation is the last surviving remnant of a steppe which covered the ground before the sandy desert was formed, and since the invasion of the sand has been smothered by it? In this zone of the desert all the tamarisks are dead, and their branches and stems as brittle as glass. But that they were once strong and full of sap is evident from the notable dimensions they often attain. Why then have they died? Is it because the level of the ground-water has dropped, or is it that the surface of the desert has in the course of time risen? Possibly it is both these causes combined that have been operative. The kamisch on the other hand appears to be more tenacious of life; you see it growing fresh and strong close beside the dead tamarisks, though whether its roots are longer than those of the tamarisk, or whether it is satisfied with the transitory moisture that is able to acidify the soil, I do not know.



Fig. 285. FOLLOWING THE CREST OF A SNOW-COVERED DUNE.

During the day the snowy coverlet, in consequence of the sun's power, underwent certain changes as it thawed and froze again. The farther we travelled towards the south, the deeper lay the snow; in other words, the snow-fall was heavier in the regions that lay nearer to the mountains, and was less towards the north. Perhaps it had altogether failed to reach the middle of the desert. On the convex summits of the dunes looking towards the north, the snow lay decimeter thick; and

it was equally thick on the southern side of the actual crest. On the same side, but lower down, it was crusted over, so that you could without difficulty have ski'ed down it; and as the afternoon wore on, the hardness of the surface increased. Along the southern faces the snow which lay next to the surface of the sand had evidently thawed, for the sand itself was frozen to the depth of 2 to 3 cm., and when the camels slid down these steep slopes, patches of the hard, frozen sand, as much as 20 square meters in extent, used to descend with them, carrying along at the same time their coverlets of snow as they glided down over the loose, unmoistened surface; the snowy edges of the crests thus exposed to the noonday sun were frozen so hard that they did not break even under the weight of the camels. And so slippery

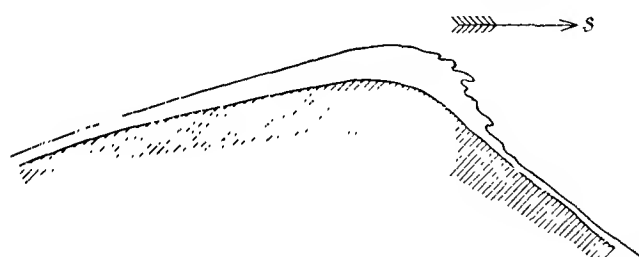


Fig. 286. FROZEN SNOW ON THE CREST OF A DUNE.

were they that the camels, until they learned not to tread on them, used frequently to fall. On the other hand the frozen leeward face, looking towards the south or the west, would not bear, but broke under their footsteps. It is just this saturation of the sand — it was now 2 to 3 cm. deep — by the thawed snow which produces

the harder laminae of which I have been speaking. The same effect is of course produced by a spring rain, though the lamina so originated is not indeed so thick. On the other hand none of these changes occasioned by thawing and regelation were to be observed on the slopes that look towards the north. There the sand was as usual loose, and in the holes left by the camels' feet, the dry snow used to mingle with it. And before any thaw can set in there, as a consequence of the general rise in the temperature of the air in spring, the snow has evaporated so that the retarding effect, which it may possibly have upon the movement of the sand when the first storms of spring come, cannot be very great. On the other hand, the moist layer of sand on the southern slopes becomes all the thicker when the snow begins to thaw from underneath. The 2 to 3 cm. spoken of above were

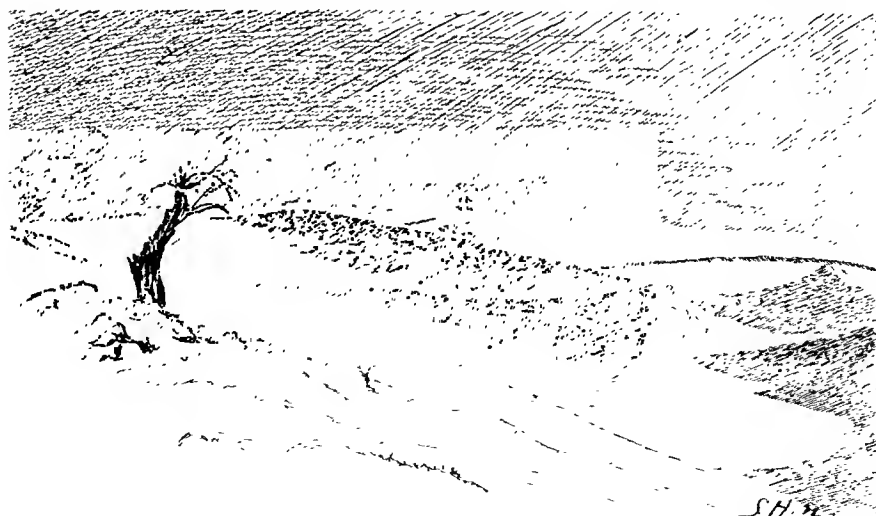


Fig. 287. SNOW-COVERED DUNES.

the result of one or two days of sunshine. As soon as the snow has disappeared, the moisture quickly disappears also, though its cementing and solidifying effect remains, imparting to the lamina in question a firmer consistency than that possessed by the lamina of sand which is swept over it by the first storm of spring; so that we can now understand, how it comes to permeate the entire dune, and how in especial it shows itself on the surface in ridges and ribbings. I question very much whether a winter storm would have any effect upon the relief of the dunes, for the snowy covering acts like oil upon the waves.



Fig. 288. DEAD TOGHRAK-TRUNK IN THE DESERT.

As the sand ahead of us appeared to be impassable, we turned to the west, and finally struck a hollow containing two or three dead tamarisks. We were now 18 km. beyond the point where, according to Roborovskij's map, we ought to have crossed the old bed of the Tschertschen-darja, of which he had been informed; but so far there had not been the smallest hollow to indicate the presence of any such ancient watercourse.

Of vegetation on the 6th January, except for two dead tamarisks, we did not see so much as a drifting leaf; nor anything indicative of a bajir all day, while the dunes were steep and difficult. In general the underground contour seemed to be rising as we approached the mountains. True, there was no great indication of this on my hypsometrical instruments, but it was noticeable that the view looking north was



always more extensive than that to the south. The snow still continued to grow deeper as we advanced, although it had settled a little and hardened, so that it covered the dunes as with a parchment-like skin. In places the yellow sand was beginning to peep through on the southern slopes. There was no scarcity of water, and in the evenings we used to thaw the snow, and so husband our last surviving pieces of ice; we no longer had any occasion to dig wells.

On the 7th January we did a tolerably heavy march through high sand. In a hollow we again encountered vegetation, namely *kamisch* and *köürük*, a species of the tamarisk order, but both it and the *kamisch* were dead. Here however we came upon sure indications that we were approaching the Tschertschen-darja, namely some cow-droppings, which appeared to be one or two years old. How this encouraging indication came to be in that place it is difficult to surmise, for what cause could there exist why the animal should choose the desert sand for an airing? Another equally unmistakable sign was a belt of poplar-forest, venerable trunks, long dead and withered, though in one place still standing thick together. Many of them were sound and solid, others hollow; most of them still stood upright, some with, some without, mounds at their foot, while yet others lay prone amongst the sand. A soft piece of *kotäk* (dry timber) bore plainly the marks of an axe; but very many years must have elapsed since the lusty tree was felled. Owing to the high sand I was unable to see in which direction this belt of toghrak extended; but it seems to me not unlikely, that it marks an older bed of the Tschertschen-darja, otherwise it is difficult to understand how this strip of forest could come into existence. It will in that case have withered since the river changed its course. If this assumption is right, we have here a fresh example of the tendency which the rivers of East Turkestan show to gravitate towards the right, irrespective of the direction in which they flow. Amongst the dunes too there were occasional terraces of clay, horizontally disposed, and resembling the dried escarpments beside an abandoned river-bed. Nevertheless I cannot say, that there were any actual and unmistakable signs of a former river-bed.



Fig. 289 and 290. VIEWS FROM OUR LAST DAY'S (8 JAN.) MARCH THROUGH THE DESERT.



The processes of thawing and regelation now produced upon the surface of the snow fresh crystallisations in the form of thin three-pointed flakes, resembling oak-leaves, about 1 cm. across, and pointing towards the south-east. Possibly the wind, which was then blowing from the north-east, may have had something to do with their formation.

Early on the 8th January the belt of *kötäk* came to an end, and we were again amongst the high sand, although every now and then we perceived a tree-mound, and a couple of living poplars or tamarisks amongst the dunes. The sand was once more arranged in the familiar characteristic bajir-formation. Although the depressions were of miniature size, they were fenced in on the east by the same steep dune-wall, at the foot of which dwarf tamarisks were sometimes growing without the usual mound underneath them. In several of these bajirs the ground again consisted of dry and brittle clay, horizontally disposed, not of soft loose *schor* as in the northern part of the desert. On the west side of each bajir the clay was shaped into very low terraces, and descended in steps towards the eastern side of the bajir, where the depression was consequently deepest, as in the bajirs in the north of the desert and in the Tarim lakes. The formation of these southern bajirs is shown in the accompanying section (fig. 291); and as the same conformation occurs in them all, it is plain that it cannot belong to the original substratum, but is caused by the superincumbent sand. The sand-free clay surfaces, that is the bajirs, have been excavated by the wind, and the portion *a* has been exposed to this action for a longer period than the portions *b*, *c*, and *d*. In the case of the larger bajirs we found that there is an uninterrupted slope from west to east; here however the surface is broken into low terraces, with sharp edges. On the west these merge into the windward flank of the nearest accumulation of sand. In some places we perceived fresh kamisch growing in the deepest parts of the bajirs.

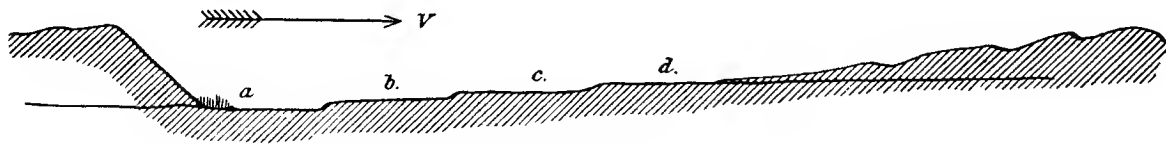


Fig. 291.

At length, from the summit of a lofty dune, we caught sight of the longed-for black line to the south, indicative of the forest belt of the Tschertschen-darja. The last dunes went down towards it with a very long and gradual slope. The tamarisks were here standing as usual each on its characteristic mound, but the border-line, which not a single one of them overstepped, was extremely sharp. Between the last dune-crest and the tamarisk-belt there was a long depression or hollow, extending in both directions as far as we could see; possibly it was the last relic of an ancient bed, although it did not run parallel to the existing river, but struck it at



Fig. 292.

an acute angle. The tamarisks, the cones of which were 2 to 3 m. high, grew very close together, so that it required some care to steer our way through the labyrinth. On the other side of them we came upon thick beds of luxuriant kamisch. Then we crossed at right angles another oblong depression, which unquestionably was an older river-bed. Here then, in this part of its course, the Tschertschen-darja appears to have flitted step by step towards the south. Some vegetation had established itself along the bottom, while certain of the withered tree-trunks which lay separate may well once have been driftwood brought down by the stream. After that the kamisch and tamarisks alternated one with the other. There was also a clump of poplars; but, strange to say, although so close to the river, the trees were dead. Possibly they had died in consequence of some former alteration in the bed of the stream. Their trunks were quite hollow, like reeds. We pitched our camp beside the river, which was frozen to a considerable depth and covered with snow. In this locality, which is known as Keng-lajka, the road to Tschertschen runs immediately along the left bank of the river, where there is a thin poplar forest. Although not more than 6 to 8 meters high, yet being the only trees in a region in which trees of any kind are a rarity, these poplars naturally produce a somewhat impressive effect. The vegetation on the right bank of the river appears to be of the same character as that on the left. Here too there is a desert tract with dunes, though, judging by its name of Kum-tschaval, not without interruptions. Indeed there are said to exist numerous small patches of forest, kamisch, and *kötäk* or dead forest.

The river here was about 100 m. wide, this great width being however solely due to the fact that, after the first freezing, the water flows out over the ice, and then freezes again, and so goes on spreading wider and wider after each fresh overflow. This I infer from the numerous small islands of kamisch which I saw sticking up through the ice, for they would not be able to maintain their ground in the running stream. Three shepherds, who were grazing 400 sheep at Tasch-kitschik on the right bank, told us, that the river had been frozen for 20 days. Thus the Tarim freezes at an earlier date than the Tschertschen-darja, the latter stream having the greater fall, and consequently the greater velocity. In the 25 days immediately preceding the freezing of the river, its surface had been thick with *kömul* or *kade*, i. e. drift-ice. The shepherds expected the ice would remain  $2\frac{1}{2}$  months longer. The snow began to fall here seven days before, precisely at the same time as it began to fall in the desert. During the last three days a hard *tagh-schamal* or »mountain-wind» had been blowing. To the south-east we saw, the atmosphere being again clear, a massive portion of the Tokus-davan. The commonest animals at Keng-lajka were wolves, foxes, *molun* (a species of *Felidæ*, probably wild-cat), hares, pheasants, wild-duck, etc. Although the tiger was known lower down, he does not frequent this locality. Owing to the great number of wolves, roe-deer, red-deer, and antelopes are rare, but they are more numerous at Boghuluk, especially the second; in fact the place is named from them. Here there were said to be no wild camels at all beside the Tschertschen-darja.

## CHAPTER XXII.

## ON DUNE-FORMATION AND SANDY THRESHOLDS.

I had thus succeeded in crossing the Central Asian desert at one of its broadest parts, the distance being 284.5 km., equivalent to the distance between London and Liverpool, Berlin and Breslau, or Stockholm and Jönköping. Had I struck a line from any point between Tepe-teschdi and Arghan to Tattran the distance would have been about the same; for, if a circle be drawn with Tattran as centre and 285 km. as its radius, its circumference would almost exactly coincide with the arc of the lower Tarim. We struck the Tschertschen-darja 7 km. below Tattran, although it had been my object and my endeavour to steer straight for that village; my failure to achieve this purpose depended partly upon the variation of the compass, and partly upon the deviation of the chain of bajirs from the straight line leading to Tattran. But before attempting speculatively to account for this deviation, in the course of which we travelled first south-west, then south-south-west, then south, and finally even south-south-east, I add a table supplying the actual data upon which I base the following discussion.

Bajir no.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	ran	S.	32°	W.
»	»	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	31°.	6 W.
»	»	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	41°.	5 W.
»	»	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	41°	W.
»	»	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S	20°	W.
»	»	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	35°.	5 W.
»	»	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	37°	W.
»	»	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S	38°	W.
»	»	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	10°.	5 W.
»	»	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	31°	W.
»	»	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	24°	W.
»	»	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	21°.	5 W.
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»	»	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	»	S.	27°	W.



meters, Keng-lajka lies at 1,180 meters, so that in the course of our journey between these two places we had ascended 300 meters. Thus the Tschertschen-darja has a fall towards the Kara-buran 300 meters greater than that of the Tarim, although the distance is only very slightly longer. And the difference becomes still more sharply accentuated, when it is remembered that Jarkent and Tschertschen stand at the same altitude, although the distance between the former and the point of confluence of the two rivers is 1,250 km., whilst from Tschertschen to the same point it is only 450 km.\* The contour-lines of the East Turkestan basin thus cut the long bajir-groove virtually at right angles; consequently this latter has nothing whatever to do with the conformation of the surface or its relations of level.

The meteorological journal gives information as to the direction and so forth of the winds in the Lop country during the course of my stay there. The prevailing winds come from the north-east quarter, with a stronger inclination to the east than to the north: that is they blow from the east-north-east more frequently than they blow from the north-east. It is very seldom that the wind comes straight out of the east, and I have never observed it blowing from due north. As a general rule we may take it that the prevailing wind comes from the N. 60° E. Disregarding any effect that may be produced by differences of magnitude in the particles of sand, — the shape of the dunes is determined by the wind and the relief of the ground. On perfectly level ground, and under the influence of a strong and steady wind, the individual dunes assume the shape shown in the annexed illustration (fig. 293): they are crescentic in outline, have a steep face towards the west, are highest in the centre, and slope away in each direction towards the two horns of the crescent. On the windward side they have a convex, spoon-shaped slope, formed quite regularly, but crumpled by tiny sand-waves or ripple-marks, which on the actual ridge lie parallel with the crest of the dune, but lower down are affected by the character of the slope in the same way as the dune itself is when it is built up on uneven ground. So long as the dune-formation is in its first stage, or one »storey» high, the individual dunes are scattered, though they also coalesce and fuse together in places so as to form twins and triplets, nay, actual chains of connected dunes. But in these concatenations of dunes (see fig. 296) it is always possible to distinguish the original shape of each individual dune, though the dune is of course more or less modified through fusion with its neighbours. Unless the fusion is very close, the dune will have lost little more of its original features than the



Fig. 293. INDIVIDUAL DUNE.

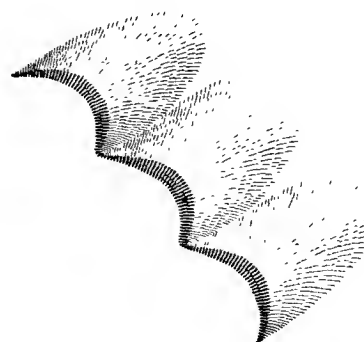
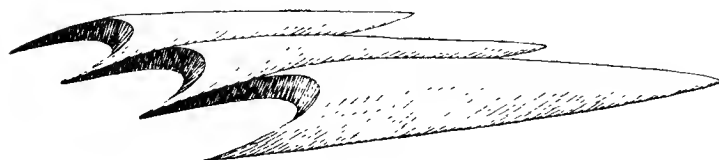


Fig. 294 and 295. DUNE-TRIPLETS.

\* The distances were measured roughly on my map in *Petermanns Mitteilungen*; if the windings of the rivers be taken into account, the distance is of course in both cases much greater.

points of the horns. The whole of the dunes in a given desert area such as is here assumed travel in the direction of the wind, that is parallel to one another. If the process of »sanding down» continues, that is if the volume of sand in the area con-

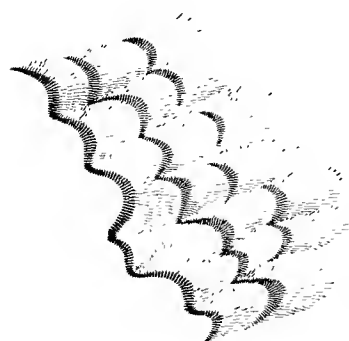


Fig. 296. ACCUMULATING DUNES.

tinues to increase, the individual dunes partly increase in size and partly become pressed closer together. Even though the surface is uniformly level, the different individual dunes are differently affected by one and the same wind. At all events this is bound to be the case wherever a higher dune acts as a partial wind-screen to a lower one situated on its leeward side. In fig. 297 *b* must travel faster than *a*. At this stage the separate dunes seem to attract each other, that is they manifest a certain tendency to approach nearer together and ag-

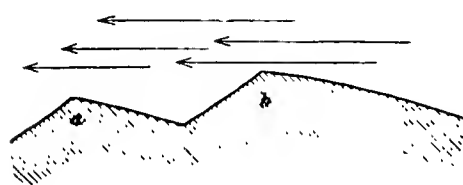


Fig. 297.

glutinate into bigger accumulations; in fact, the dune-accumulations of which I have spoken are only so many inextricable agglomerations of once discrete individual dunes. The larger dunes seem as if they tried to swallow up and absorb into themselves the smaller dunes, until they form continuous ridges or accumulations. The process is a quite natural one. Suppose in the accompanying cut (fig. 298) that B and C are individual dunes which have successfully climbed up over the dune A, then in the position which they assume, B will move faster than A, because of the latter being relatively sheltered from the wind. In the second cut the dune B has overtaken A, and in consequence the new dune A + B is twice as big as the original dune; but

on the other hand the rate at which A + B moves is only half as great as that at which B moved. The dune C may be assumed to possess the same dimensions as B; consequently it too will travel twice as fast as A + B. Hence it will overtake it,

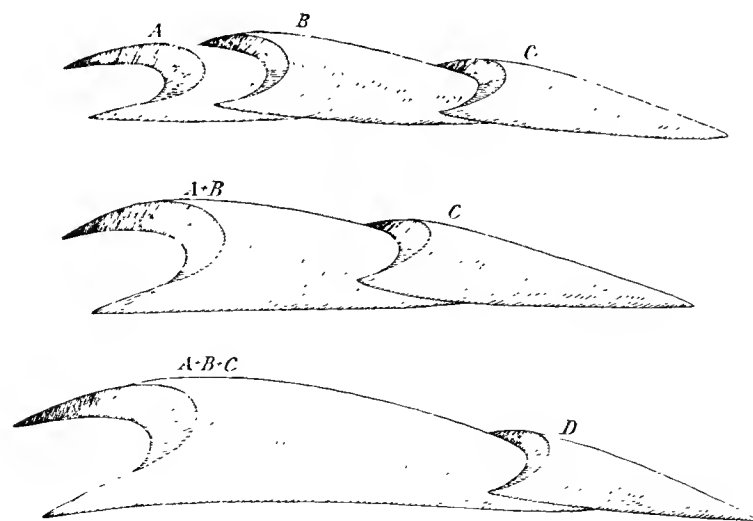
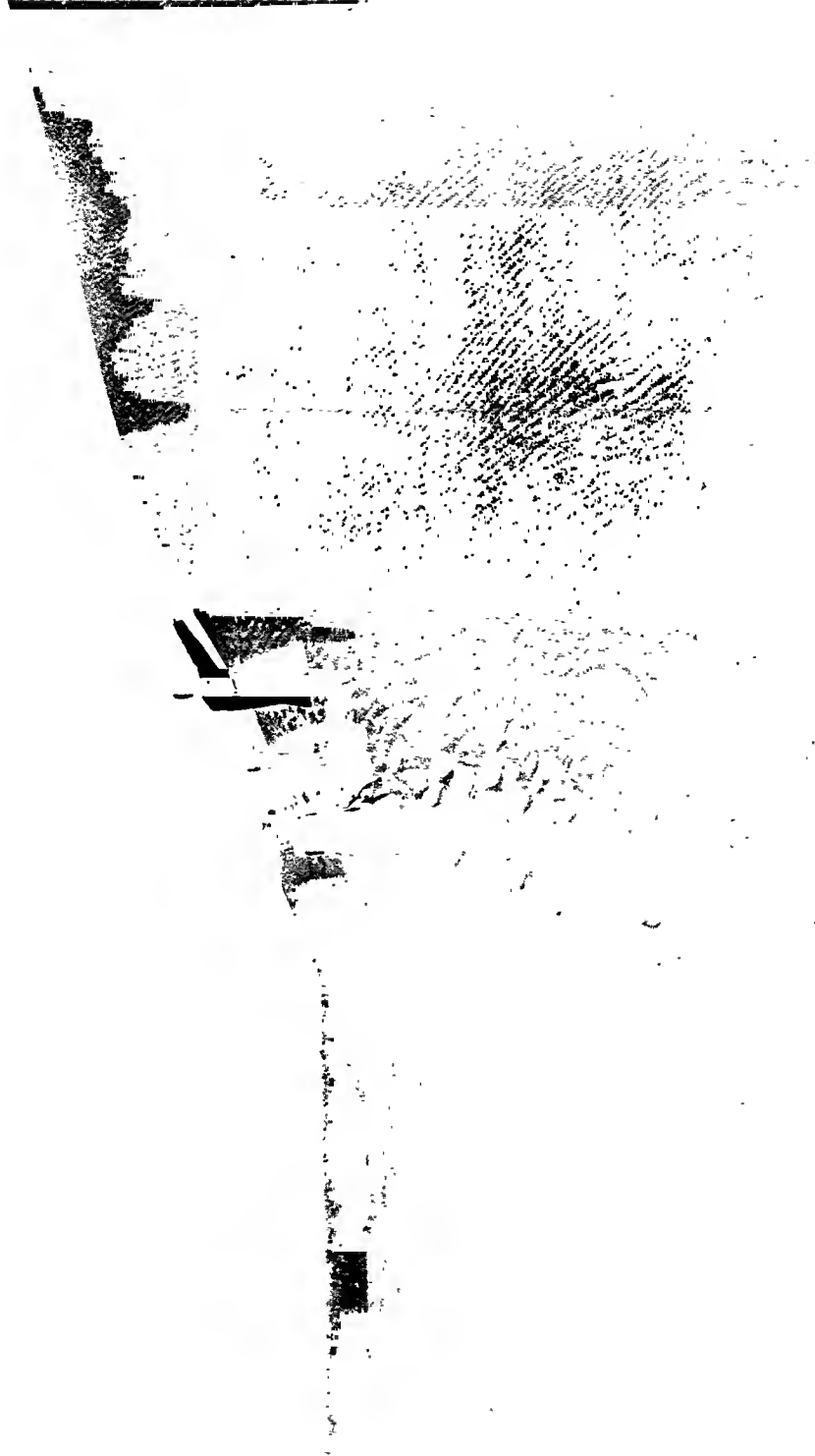


Fig. 298.

raising still higher its steep leeward face, though this will, it is true, decrease in proportion as the compound dune increases in breadth. Thus, whilst the mass and the altitude of the compound dune-accumulation increase, so too does the relatively greater velocity of movement of the advancing individual dunes, that is as compared with the compound dune. So that the more dunes there are which go to make up a dune-accu-



*Ljustr. A. B. Lagrelius & Westphal.*

SAND-ACCUMULATION ON THE RIGHT BANK OF THE TARIM.

In the Background the River and Toghruk Forest.





mulation, the slower becomes its forward movement. At all events, it certainly forms a boundary beyond which the individual dunes under no circumstances advance; they can, and do, move onwards until they come to the very top of the accumulation, then however they disappear, and their individuality ceases. Even when this process, as exhibited in the three figures here appended, is continued in both directions as shown in fig. 296, their mutual relations still remain always the same.

Now this could only happen in a country like East Turkestan, where the surface is so level and flat, and so perfectly undiversified — where there are not even minor undulations, and where the prevailing wind is so extraordinarily powerful and so unchecked in its operations. I doubt whether there is anywhere a sandy desert which exhibits such regular and such beautiful sand-formations as the Desert of Tschertschen, for the predisposing conditions which I have mentioned above are nowhere so strikingly developed as there. After crossing this desert, as I have done, and after seeing with my own eyes the extreme regularity of construction which prevails everywhere throughout it, and witnessing how for days together these sharply accentuated concatenations of sand-hills never vary in their features from one end to the other, I do not for one moment hesitate to declare, that each such accumulation or range is built up of innumerable individuals, which, advancing from the east-north-east, climb up, as it were, to the highest summit of the range, and then fling themselves down its steep westward face, and so disappear. Having witnessed this myself, I do not hesitate to say at once, that on level ground and under a steady wind, the individual dunes endeavour to fuse with one another to form a concatenation of sand-hills, or more correctly speaking an unbroken continuous ridge (*d̂s*). To observe *in situ* what actually takes place in the sand during a spring storm would require not only a long period of observation, but also a great amount of patience. It must suffice to remind the reader, that the reasoning which I have adduced above is in almost exact agreement with the general laws of the formation of waves (kumatology). If you examine a small individual dune whilst a violent wind is blowing, you find that the minute ripples of its surface, the tiny beautifully formed wavelets of sand, travel up the windward side until they reach the top, where they disappear, and that these are constantly followed by others so long as the wind continues to blow. Precisely the same thing takes place with regard both to the individual dunes and the large sand-waves, which represent the highest power of sand-agglutination. And just as the fine ripples travel faster than the dune on which they move, so the individual dunes travel faster than the dune-accumulation to which they temporarily belong. Thus the velocity is proportional to the mass. The same law obtains in the waves of the ocean: amongst them the ripples grow into waves, and the waves into huge foam-crested billows. When a violent wind strikes a perfectly smooth expanse of ocean, it gives rise, within the course of merely a few seconds, to a uniform rippling of its surface; in precisely the same way the wind acts upon every point of the surface of the sand, the continuous wave-movement of the ripples being disregarded. But when the wave-crests are piled up by a long-continued wind, they do not lose their individuality; they absorb all the smaller waves and go on growing unceasingly. If the wind suddenly ceases, the

movement still persists, and does so for some time even after the wind has changed its direction. The topmost summit is indeed capped with smaller waves, precisely as the dunes are. If the waves of the sea are sufficiently large and sufficiently powerful, they are but little affected by a feebler wind setting in from another quarter. In the same way the sand-accumulations of the Desert of Tschertschen are never affected by the winds which blow from any direction except from the predominant quarter. It is in both cases merely the surface that is affected by the change of wind: that becomes rippled, and the ripples augment and grow into waves or small individual dunes.

If now the entire mass of sand were to be evenly distributed over the surface of the whole of the desert, and *its* surface were to be perfectly horizontal, sandy ridges that would be then formed would be disposed at right angles to the direction of the prevailing wind, and would assume the position *b* indicated on the accompanying sketch-map (see Pl. 52). But as a matter of fact, they actually assume, as we found, whilst crossing the desert, the position *a*, for the chain of bajirs which we followed ran between two parallel accumulations of sand. Special circumstances must conspire together to produce this apparent anomaly. How far the pressure of the wind is the same throughout the entire region, that it is from Jangi-köl to Keng-lajka, cannot be determined; but it is possible that its force is to some extent modified in the northern part by the Kuruk-tagh and the forest-tracts beside the Kontsche-darja, and as a consequence of this that the extremities of the dune-ranges which project so far north are in some degree retarded, and unable to advance with the same speed as those parts which lie directly exposed to the wind.

Moreover, we know that Keng-lajka lies 300 m. higher than Jangi-köl, and we may assume that the rise to the first-named is everywhere equal and uniform throughout the area in question. And perhaps this circumstance is not without its effect, however small that may be. Certainly it is not admissible to say, that as the pressure of the wind is four times greater on the summit of the Eiffel tower than at the surface of the earth, in like manner it must be greater at Keng-lajka, because that place lies 300 m. higher than Jangi-köl, for, as I have supposed, the inclination is about the same in all parts of the desert, and the wind sweeps unchecked over every portion of its area alike. The 300 m. difference of elevation is distributed over such an enormous stretch of country, 1 in 930, that really it scarcely comes into account; at any rate, its effect is quite insignificant. If however we were to assume that this difference of elevation, or of relief, did possess any importance, it would contribute to deflect the sandy ridge in the direction indicated by *a* in the illustration, and also in the way there shown. In that case those parts of the accumulation or concatenation which are situated on higher ground would be more exposed to the wind than its lower-lying parts; and the southern portion of the dune-accumulation would advance faster than the northern portion.

However there is another factor which appears to me to exercise a definite and determinative influence, and, quite independently of the causes cited above, to be sufficient to explain the phenomenon. That is the greater abundance of sand there is in the north of the desert as compared with the south, or in other words, the sand decreases in quantity as one travels from north to south. If now the velocity

is proportional to the mass, it follows that the heavier and bulkier dunes of the north will travel more slowly than their less massive prolongations towards the south. Thus, instead of presenting itself in a straight line at right angles to the direction of the prevailing wind, the dune-concatenation becomes curved, so that, whilst in the north it lies at an acute angle to the direction of the wind, in the south it approximates more and more towards a right angle. The table on p. 349—350 shows plainly the course of the curve, both in the case of the dune-concatenations and of the chains of bajirs which lie between them. Bajirs 3 and 4 lie almost north-east and south-west; after that the southern direction becomes more and more pronounced, although there are of course at the same time several deviations from a curve proper. Throughout the whole of the northern half of the desert there does not exist a single bajir with an eastward inclination; bajirs exhibiting that tendency appear only in the southern part of the desert, and in the extreme south the eastward inclination is more common than the western. This applies to bajirs no. 19, 24, 28, 30, one-half of 33, 36, 39, 41, 42, 43, 44, 46, and all the miniature bajirs, their mean inclination being  $12^{\circ}.5$  E. Hence the angle which this makes with the prevailing wind is  $72^{\circ}.5$ . Let us take a few bajirs at random, and see how they lie with respect to the wind. We find

No. 1 = $28^{\circ}$	No. 23 = $48^{\circ}$
» 4 = $19^{\circ}$	» 28 = $92^{\circ}$
» 11 = $36^{\circ}$	» 32 = $55^{\circ}$
» 17 = $53^{\circ}$	» 40 = $37^{\circ}$
» 19 = $74^{\circ}$	» 41 = $87^{\circ}$

From this it is clear that the angle increases, although irregularly, as one advances southwards. Throughout the entire series there is only one bajir, namely the eastern half of No. 28, in which the angle exceeds a right angle. The one after that which comes nearest to a right angle is No. 41, its angle being  $87^{\circ}$ . The great difference that exists between bajir No. 4 and bajir No. 41 is shown in fig. 299 and 300; for whereas the former lies S.  $41^{\circ}$  W., the latter lies S.  $27^{\circ}$  E., or a difference of  $68^{\circ}$ . Even between No. 40 and No. 41, close as they come together, there is a difference of fully  $50^{\circ}$ . Thus the whole of the dune-accumulation does not advance at the same rate throughout, but certain parts lag, as it were, behind. It is precisely what may be observed in a small series of dunes which have fused together, the one wing is smaller than the other, and consequently is driven forward by the wind at a faster rate. The varying angles show that the dune-concatenation does not possess the same degree of massiveness throughout.

The circumstances being then thus, one would expect that some parts of the sandy mass would drop behind and get cut off from the rest; and this is what actually does take place. In the case of the waves of the sea one may often observe a break in the succession, that is waves which run off from the main mass and dwindle away. Disruptions and severances of this kind are commoner in the south of the desert than in the north. For instance, from bajirs 1 to 15 inclusive we had identically the same unbroken sandy wall on our left hand throughout; but between No. 9 and No. 10 we were able to perceive preliminary tendencies towards a bulging

outwards, and similarly between No. 13 and No. 14. But the first real breach in the wall occurs between No. 15 and No. 16, in that the dune which fences in bajir No. 16 on the east has advanced considerably farther towards the west than that which bounds No. 15 on the east. Bajirs 16 to 20 inclusive possess one and the same sandy wall, and it occupies a more westerly position than the sandy wall which bounds Nos. 21 to 27 inclusive. No. 28 is divided into two by a sandy spur. Another dune-wall is common to Nos. 29—35, though it is less straight and less continuous than those which I have already named. Another spur juts out between Nos. 36 and 37. Bajir No. 38 possesses a very distinct dune-wall, but it soon becomes lost amongst the sands which stretch to the south of it; and from that point the regular accumulations of sand gradually die away, and the steep dune-walls become shorter and shorter. In the extreme south this same conformation distinctly reappears, although on a very much smaller scale than in the north. Thus

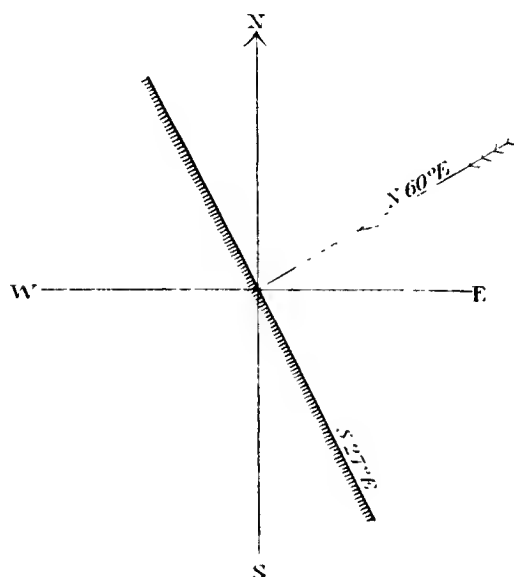


Fig. 299. DIRECTION OF THE DUNE-ACCUMULATION ON THE EASTERN SIDE OF BAJIR NO. 41.

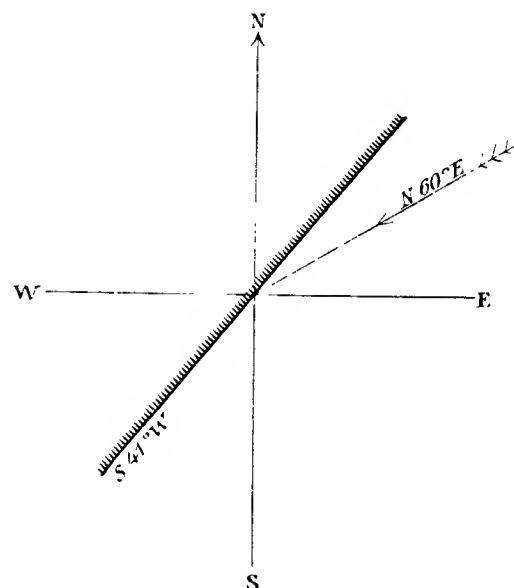


Fig. 300. THE SAME IN BAJIR NO. 4.

there exists a belt of exceptionally irregular formation in the middle of the southern half of the desert. This may possibly be conditioned by some inequality of the substratum or underlying surface, though it is of course masked by the dunes, and is not visible to the eye.

In the chapters which deal with the marginal lakes situated amongst the sand on the right bank of the Tarim I have discussed the origin of the sandy thresholds or isthmuses, that is to say, the low necks of sand which frequently divide the lakes into two basins and in the desert separate the bajirs one from the other. One cannot of course speak with perfect certainty with regard to this problem without having precise and accurate data to go upon, including measurements by means of graduated staves exposed throughout the whole of at least one storm-period. In default of such data, my statements only claim to explain the causes of the existing arrangement of the sand. But this may at any rate safely be laid down, that im-

mediately opposite to each threshold in the chain of bajirs there is an expansion or swelling of the dune-range situated west of the threshold. An example of this is shown in the annexed sketch (fig. 301) of the threshold, not yet quite mature, which parts bajirs No. 9 and No. 10. The same thing is true (see fig. 303) of each compound dune-length that has reached the stage in which the highest individual dunes trail the longest »tail», *b*, behind them. And even when we have several successive stages or »stories» represented, when the dunes have climbed up over each other, the relations remain exactly the same; that is, they are precisely such as we have found in the immense sand-accumulations. As the tongue of sand *b* must enjoy relatively greater shelter from the wind than any point (*c*) whatsoever, its advance westwards is obviously retarded, until eventually it becomes overwhelmed by the sand-wave *a* (fig. 301). If now several compound dune-lengths follow after one another, like the waves of the sea (fig. 303), there ensue sand-free spaces *B* in the parts which lie to the windward of the lowest dunes *c*; and these depressions are bordered by the »tails» of the highest dunes (*b*). When exemplified in its greatest conceivable degree, the arrangement becomes what we found it in the Desert of Tschertschen, amazing though it may at the same time be in its regularity.

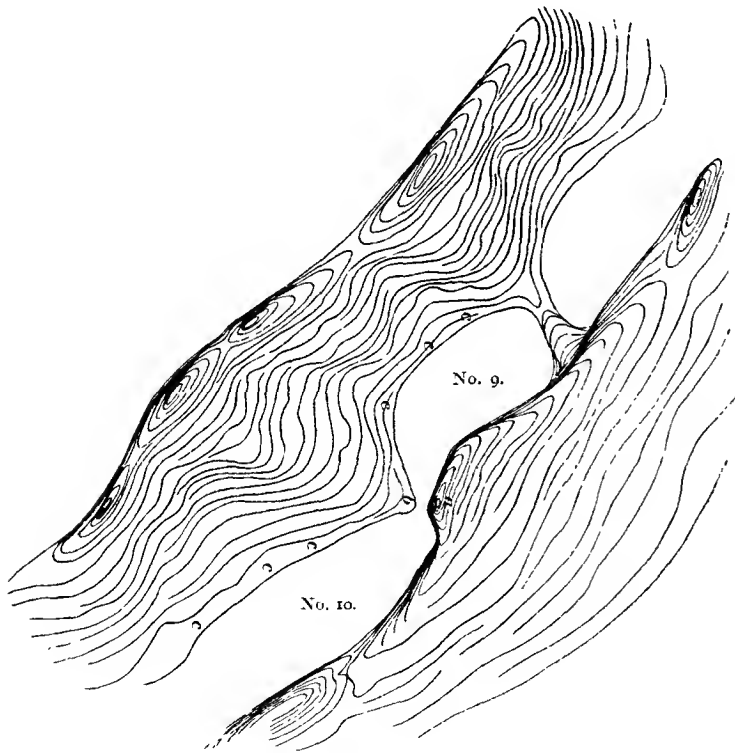


Fig. 301.

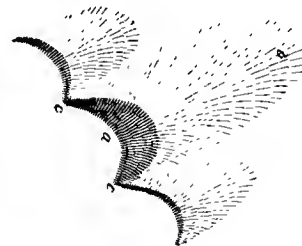


Fig. 302.

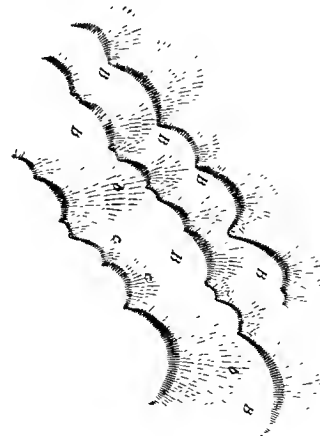


Fig. 303.

As a rule in the districts nearest to the Tarim, we find that each sandy threshold corresponds to a westward bulging or swelling of the sand-wall that shuts it in on the east, as for example the threshold between bajirs Nos. 1 and 2 (see fig. 304). Here, too, I believe I am right in saying, that the swelling is higher than

other adjacent parts of the crest of the same accumulation. Now this is in contradiction to the law which I have enunciated, that the rate at which the dunes advance is proportional to their mass. It must not however be forgotten, that other factors may possibly impair the validity of the law. Take the projection of a dune-length, seen foreshortened in perspective (fig. 307), the crest at the transverse section  $abc$  is considerably higher than the crest at  $a_1 b_1 c_1$ , and consequently is more exposed to the wind. Here then the wind puts forth greater energy, and its effect may perhaps countervail the retardation of advance which otherwise would be entailed by the difference of mass. I do not however venture to speak with any degree of positiveness upon this point; for after all it may have been an optical illusion which led me to suppose that the overhanging leeward wall of sand was highest at the thresholds. In a compound dune-length with only one store (*étage*) of dunes (see fig. 302) the parts of the leeward side which are most advanced are  $c$  and  $c_1$ , and these are also the lowest.

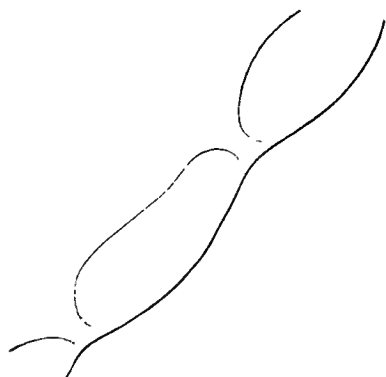


Fig. 304.

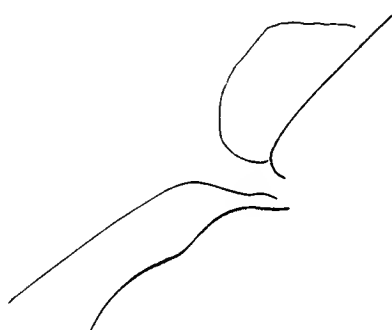


Fig. 305.

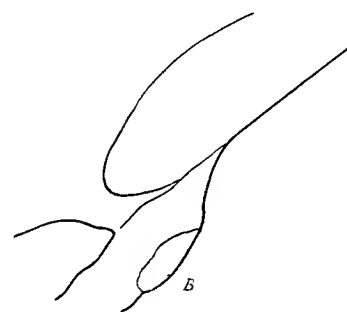


Fig. 306.

Farther in towards the middle of the desert there exist many irregularities in the relation which the leeward dune-wall bears to the threshold below it. In three places, for example, between bajirs 3 and 4, we even find a cessation or shallow breach in the wall (see fig. 305). Between bajirs 4 and 5 we have a bifurcation of the advanced part of the dune-wall (fig. 306), giving rise at  $B$  to a smaller bajir, though it is for the most part sanded up. In fig. 308 we have a rough sketch of the situation in bajirs 13, 14, and 15, where the large threshold, interrupted by two small level patches, conjoins with the steep dune-wall to form a distinct re-entering angle towards the east; whence we may infer that the formation of similar angles pointing to the west is not the rule at these thresholds. Fig. 309 shows the breach in the dune-wall between bajirs 15 and 16; as will be seen, the wall that terminates beside the former tails out towards the south, until it merges in and disappears amongst the dunes. The next fig., 310, represents the complicated situation at the southern end of bajir no. 20, where there were depressions on both sides of our route that

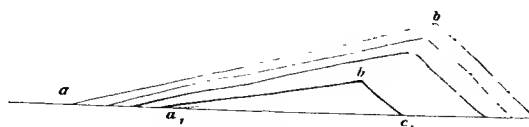


Fig. 307.

Pl. 51.



*Ljustr. A. B. Lagrelius & Westphal.*

VIEW LOOKING S. FROM THE TOP OF A DUNE-ACCUMULATION.





we were able to look across. Here the parallelism which prevails farther north had plainly ceased, and it would be incorrect to speak any longer of a continuous chain of bajirs. The two bajirs which we here left on our right lay almost at right angles to the direction of the prevailing wind. Fig. 311 reproduces the divided bajir

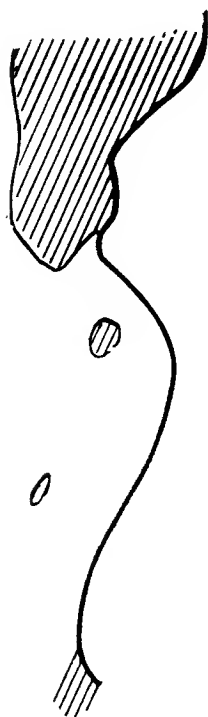


Fig. 308.

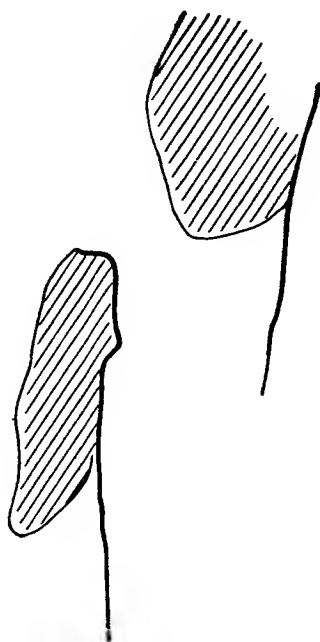


Fig. 309.

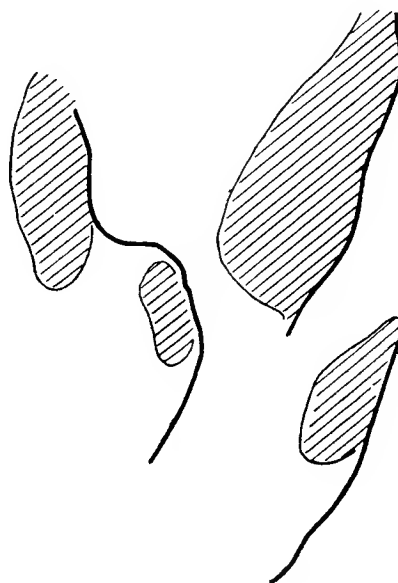


Fig. 310.

No. 28 and the broken dune-length that occasions the division; and in the succeeding illustration (312) we see the situation between bajirs 36 and 37, which is so like that between bajirs 15 and 16. The relations with regard to bajirs 40, 41, and 42, where the turning angle of  $50^\circ$  is, are exhibited in fig. 313.



Fig. 311.

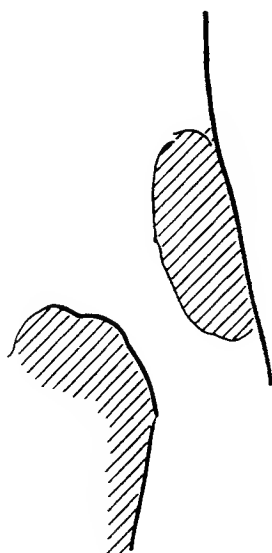


Fig. 312.



Fig. 313.

Thus there are numerous departures from the type of normal and continuous wave-crests, as caused by the varying rates at which different parts of the dune-walls advance.

With regard to the shape of the thresholds, this is shown in the two sub-joined sketches. The south face is precipitous, and from its summit the surface of the threshold slopes away towards the north. The thresholds themselves consist of several dunes which have climbed up over one another. On the west they merge gradually into the nearest accumulation; they are lowest in the middle, and highest in the east, to the leeward of the next steep dune-wall. Thus the shape of these thresholds is determined by a combination of different »wind-functions» (see fig. 265). Owing to the wind-shelters that arise both horizontally and vertically, considerable quantities of sand are heaped up towards their eastern ends. From the same cause there occurs a smaller collection of sand on the east side, immediately underneath the steep dune-wall, and in a place where otherwise there is no threshold, as for instance in bajir no. 13. In the northern part of this same bajir there exists the rudimentary beginning of a fresh threshold. Once it is formed, it will possibly retain its original shape and its original appearance for a long time, especially after

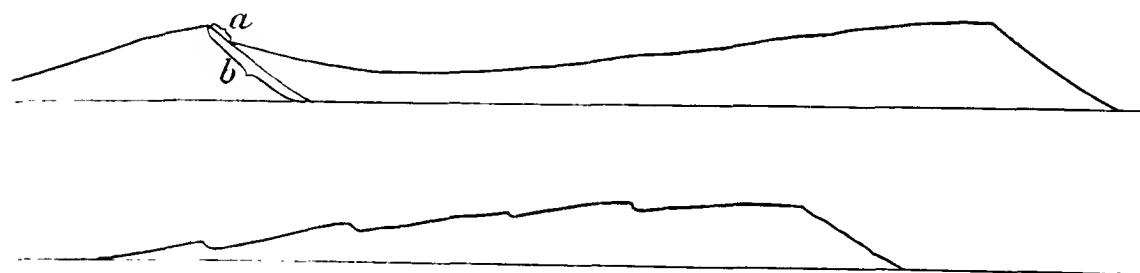
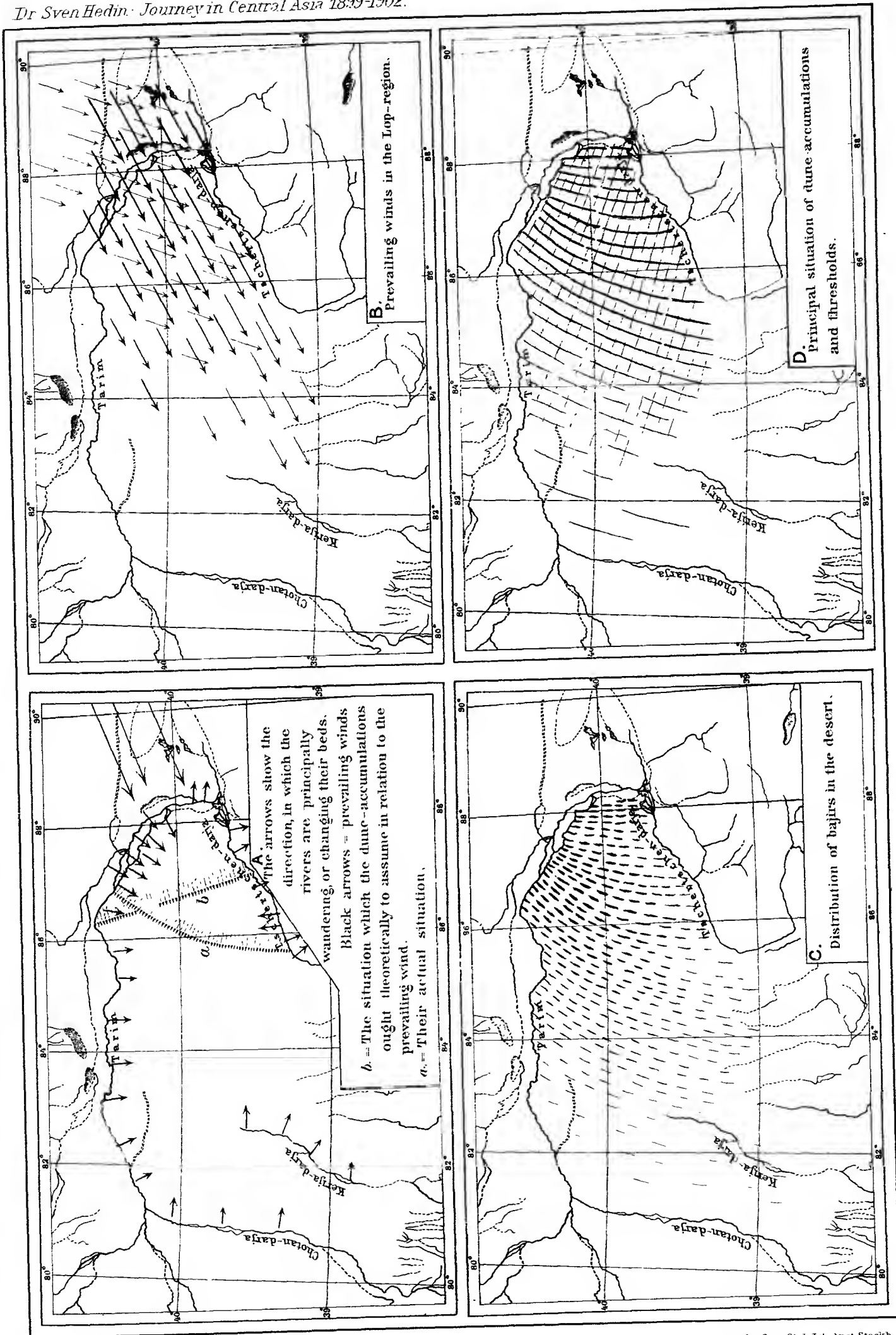


Fig. 314.

it is overwhelmed by the on coming sand-ridge. The height (*a*) through which the sand-avalanches fall from its summit is decreased by the existence of the threshold at its foot: under ordinary circumstances the height of the fall would be  $\approx b$  (fig. 314). This also may help to explain the bulging towards the west, that is to say, the succession of festoon-knots in the undulating dune-concatenation. Besides this, many other circumstances, difficult to explain, contribute to the relief formation of the sand in the desert. Strictly speaking, two dune systems can be distinctly recognised — one stretching from the north-north-east to the south-south-west, with sand-waves which die away towards the west; the other with its waves extending from west-north-west to east-south-east, and tailing away towards the south. The focus, where both systems can be most distinctly seen, and from which, as it were, they radiate through the area of the desert, is thus situated in the neighbourhood of Jangi-köl, where the wind appears to blow with the greatest regularity. The two systems intersect each other pretty nearly at right angles, and thus form a network, in the meshes of which the depressions or bajirs are situated. The second system is however quite insignificant in comparison with the first, and may be regarded as a secondary phenomenon. Indeed the thresholds, being much lower than the great dune-accumulations, cannot very well form continuous waves, and as a matter of





fact the thresholds which occur along the course of one chain of bajirs or one desert groove are independent of those which occur in the adjacent grooves: there is no continuity between them, they merely lie parallel to one another.

During our march across the desert, we observed evidences for the two following laws with regard to the construction of the thresholds. (1) They grow both broader and bigger from north to south, and in the middle of the southern half of the desert practically merge and disappear; (2) their steep leeward faces are turned towards the south-south-west. In the north of the desert the thresholds are more distinctly outlined, their borders being more sharply defined on both the windward and the leeward side; whereas in the south their margins are less distinct because of the minor dunes which project from them.

The fact of the thresholds turning their steep faces towards the south-south-west points to the predominance of winds from the north-north-east, which winds likewise impress their effects upon the surface dunes of the great dune-concatenations; that is to say, upon their surface they call forth a temporary formation of superficial dunes, which have a fall towards the south-south-west. Against the east-north-east wind the thresholds are on the contrary in great part screened, unless it is to this wind that the notch or saddle in the middle of each threshold is to be ascribed. But to the north-north-east wind the thresholds are sensitive, because it sweeps unhindered through the whole length of the bajir grooves. In other words, the dune-concatenations and the thresholds are the products of winds blowing from different quarters. The most powerful wind, the predominating wind, builds up the highest and most massive of the dune-lengths, namely the unbroken chain or concatenation of dune-accumulations; while the less powerful and less constant wind, from the north-north-east, gives rise to the lower dune-system, the thresholds or sandy isthmuses; though the real cause of their coming into existence is, as I have mentioned above, something else. The predominant winds in the Lop country blow, as we have found, from the north-east quarter, more especially from the east-north-east. But when we come to describe the Desert of Lop, we shall find that the north-north-east wind is likewise possessed of a respectable degree of power. The structure of the thresholds points also to the operation of the same wind in the Desert of Tschertschen.

If now the dune-concatenations travel towards the west-south-west, and the thresholds towards the south-south-west — as they indeed do even in that part of the desert in which there are no bajirs, and in which their steep leeward faces are all the same turned towards the west and south and south-west, nevertheless no displacement of the two systems occurs, for as appears from fig. 315, the point of intersection  $a$  coincides at a later stage of its advance with the point  $a_1$ , that is to say, the same portions of the sandy mass are in contact in both cases alike. It is for this reason that the bajirs travel towards the west-south-west and not towards the south-south-west; they move along the components of the wind's direction, and especially in the direction dictated by the east-north-east wind, which is by far the most powerful. The rate of advance in both systems would appear to be about

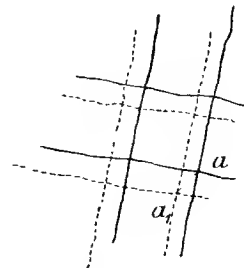


Fig. 315.

the same. True, the north-north-east wind is a good deal the less powerful, but then the sand-masses of the thresholds are also smaller. The part played by the south wind would seem to be altogether subordinate; at all events the south wind which we experienced in the winter of 1899—1900 was incapable of making any appreciable impression upon the relief of the dunes. I possess no data whatever for estimating the rates at which the two systems advance, and I prefer to abstain from guesses. At all events, it is certain that such immense masses can only travel very slowly.

With regard to the large accumulations of sand, we have ascertained the following laws — (1) In the north of the desert they turn their steep faces towards the north-west, in its middle towards the west-north-west, and in the south towards the west and west-south-west; (2) their eastern slopes ascend rather slowly towards their crests; (3) on the other side their steep leeward faces go down sheer at an angle of  $33^\circ$ , or else in two or three steps; (4) their mass diminishes towards the south; (5) they are each built up of an innumerable number of individual dunes; (6) although their relief is influenced by winds from other quarters than the predominant, their mass is unaffected by them; (7) it is their varying breadths which give rise originally to the thresholds, and consequently to the formation of the bajirs.

The following general laws apply to the bajirs: (1) They constitute so many links in the chain of depressions which in the northern part of the desert is continuous in one straight line, but subsequently in some places deviates, forms elbows, and bends like a river that flows nearly straight with few curves. (2) In regard to size they vary in a capricious way, from tiny basins of two or three score meters in extent to one of no less than 19.5 km. in length, this being bajir No. 33. (3) Of the entire distance of 284.5 km. almost exactly one-half, or 143 km., indicates the length of the bajirs, the other half being the measure of the sandy thresholds, though it is to be observed that, while bajir ground preponderates in the north, sandy ground is in excess in the south. (4) The bajir ground, or the soil in the spaces encircled by sand-waves, varies greatly in composition in different parts of the desert: in the north it consists of fine, loose, moist saliferous matter (*schor*), making the middle of the bajir as soft as a morass; in the next zone the same formation occurs again, with this difference only, that the surface is dry, and consequently can be travelled upon; in the middle of the desert the bajirs are often dotted over with small dunes lying north-east to south-west, and here a sparse and languishing vegetation makes its appearance; whereas in the south the bajirs are for a considerable distance completely sanded up, though they make their appearance again in the extreme south, smaller indeed than in the north, but possessing a hard flooring of sedimentary clay, and generally some vegetation. (5) Their general shape is that of an ellipse or an oval, though there exist numerous varieties: for instance, bajir No. 28 is horse-shoe-shaped, No. 31 almost rectangular, No. 4 is somewhat curved, whilst 33 makes almost a straight line. (6) They are deepest on the east side, close to where the sand avalanches take place. (7) They occupy the lowest parts of the intervals between two sandy waves, and correspond to the 'troughs' of the ocean waves. (8) On the east and north each bajir is bounded by perpendicular sandy walls, but on the south and west the sand has a gentle slope. (9) The bajirs travel along with

the sand towards the west-south-west, retaining their individuality as they travel, though constantly renewing the ground that lies exposed to the light of day.

In crossing the desert, the chief features of which I have described in this and the two preceding chapters, I was enabled to obtain a good general idea of its structure, though only along one single line; for the high concatenations of dunes which accompanied us on both sides prevented us from seeing very far either to the east or to the west. Nor was the weather we experienced at all suitable for reconnaissance work. But from the fact that every lake on the right bank of the Tarim has a bajir at its inner end, and from our perceiving bajirs beside us at least two or three times during the course of our march across the desert, it may safely be inferred, that it was not pure chance which led us to hit upon so advantageous a route, but that the ground would have been pretty much the same no matter which lake we had started from. As I shall prove subsequently, there are bajirs beside the Ettek-tarim, that is in the extreme east of the Desert of Tschertschen.

Now it is a natural question to ask, how far do these bajirs extend? Do they exist in every part of the desert, or where do they cease? These questions I am fortunately able to answer in the light of previous journeys. They become progressively rarer, less distinct, and smaller in size towards the west. If, for example, we consider that part of the desert which stretches between the point where the Kerija-darja dies away in the sand and the Tarim, we find (Feb. 1896) that there the steep leeward faces of the dunes look towards the south, the west, and the south-west; that the strips of scanty poplars and tamarisks, which occur there in two or three places, run north and south; but that one can also distinguish accumulations of dunes stretching east and west, parallel to the Tarim. On the crest of a dune in that locality I found a coating of snow, 2 cm. thick, embedded under a layer of sand, 22 cm. thick: this was manifestly a solitary sheet of snow which had been surprised by the first storm of spring, and subsequently protected against thawing by the thick deposit of sand.

In January of the same year I crossed the same desert between the Chotan-darja and the Kerija-darja; and there I found that as a rule the dunes stretch from north to south, and turn their steep sides towards the west. At the same time there is another system of dunes easily distinguishable, stretching from east to west, with their steep slopes looking towards the south or south-south-west. At the points where these two systems intersect one another, there are pyramidal dunes, which in elevation overtop all others in their vicinity. Nearer the Kerija-darja the directions in which these systems run are in the one case north-north-east and south-south-west, and in the other west-north-west and east-south-east, and their steep faces are all turned towards the west, the south, and the south-west. Here again there are accumulations or concentrations of dunes, running north and south, or parallel to the two rivers; but here they seem to be in some way causally dependent upon the substratum, for we found, even where the dunes are highest, small bare patches of hard clay soil, and the sand surrounding them is not any higher than it is round the bare patches that lie in between the concatenations of dunes. Now these patches of bare clay, which stretch north, north-east, and east, are of course nothing but small bajirs. The sand here does not exceed 25 m. in height, and generally is not more than 15

m., that is to say, considerably lower than the sand in the extreme south of the Desert of Tschertschen.

In the Desert of Takla-makan proper, which I crossed in the spring of 1895 from Tschoka-tagh to the Chotan-darja, the arrangement of the sand is excessively irregular. On the extreme west of that part of the desert the dunes plunge steeply down towards the west, south, and south-west, and are drawn out towards the north-north-east and south-south-west, the north and south, and the north-west and south-east. After that I crossed a belt of the desert in which the steep sides were turned to the east and south-east, though this may have been due to a chance local cyclone. Here too there are small level spaces paved with hard clay, but these extend east and west. They are however exceedingly few; we only passed a very small number. They correspond to the bajirs, although they lie in an unusual direction, and it appeared to me, that their floors are as a rule convex rather than concave. Presumably they do not fully equate with the bajirs, but are rather elevations or upswellings of the substratum, around which the sand is therefore always low, for in other parts it reaches altitudes of 50 to 60 m. The accumulations of sand occur again here, though they extend east and west, and are very flat and indistinct. Owing to the structure of the dunes, the journey through the Takla-makan was murderous as compared with that through the Desert of Tschertschen, for in the former they are not arranged in any sort of order whereby we were able to facilitate our march. No matter in which direction we had travelled, the sand would have been equally difficult and equally inconvenient.

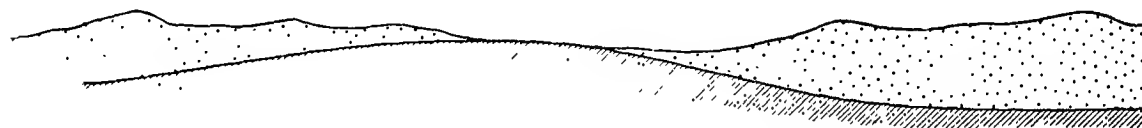


Fig. 316. CONVEX BAJIR IN THE TAKLA-MAKAN.

Hence, as the result of my four crossings of this great Central Asian desert, I may say, that its configuration and relief grow more irregular from east to west. In the extreme west, at Ordan-Padschah, where the dunes lie as a rule north and south, these would appear, judging from marks which were shown to me by the sheikhs, to travel annually 4 m. towards the south-east; there the winds blow from April to June, and the prevailing wind comes from the north-west. The sharply accentuated relief features which we encountered in the Desert of Tschertschen have already disappeared when one reaches the Kerija-darja. This is a consequence of the wind, which in the whole of East Turkestan blows nowhere with such power and such uniformity as it does in the country of Lop. The modifying effects of the east-north-east wind are here relatively so great that they easily annul the effects of all other winds put together. But in the west, winds from several quarters co-operate together to mould the relief features of the desert into capricious and changing outlines. It is in the wide open Lop country, where the mountains, the Kuruk-tagh on the north and the Astin-tagh on the south, are the nearest to each other that the wind develops its greatest and most concentrated energy. It roars like a tide pouring



through an open sluice, then spreads itself out over the basin, until gradually its violence diminishes. And this is plainly enough indicated by the sand-waves which are sculptured by it. In the east, where they are most exposed to its fiercest energy, they form

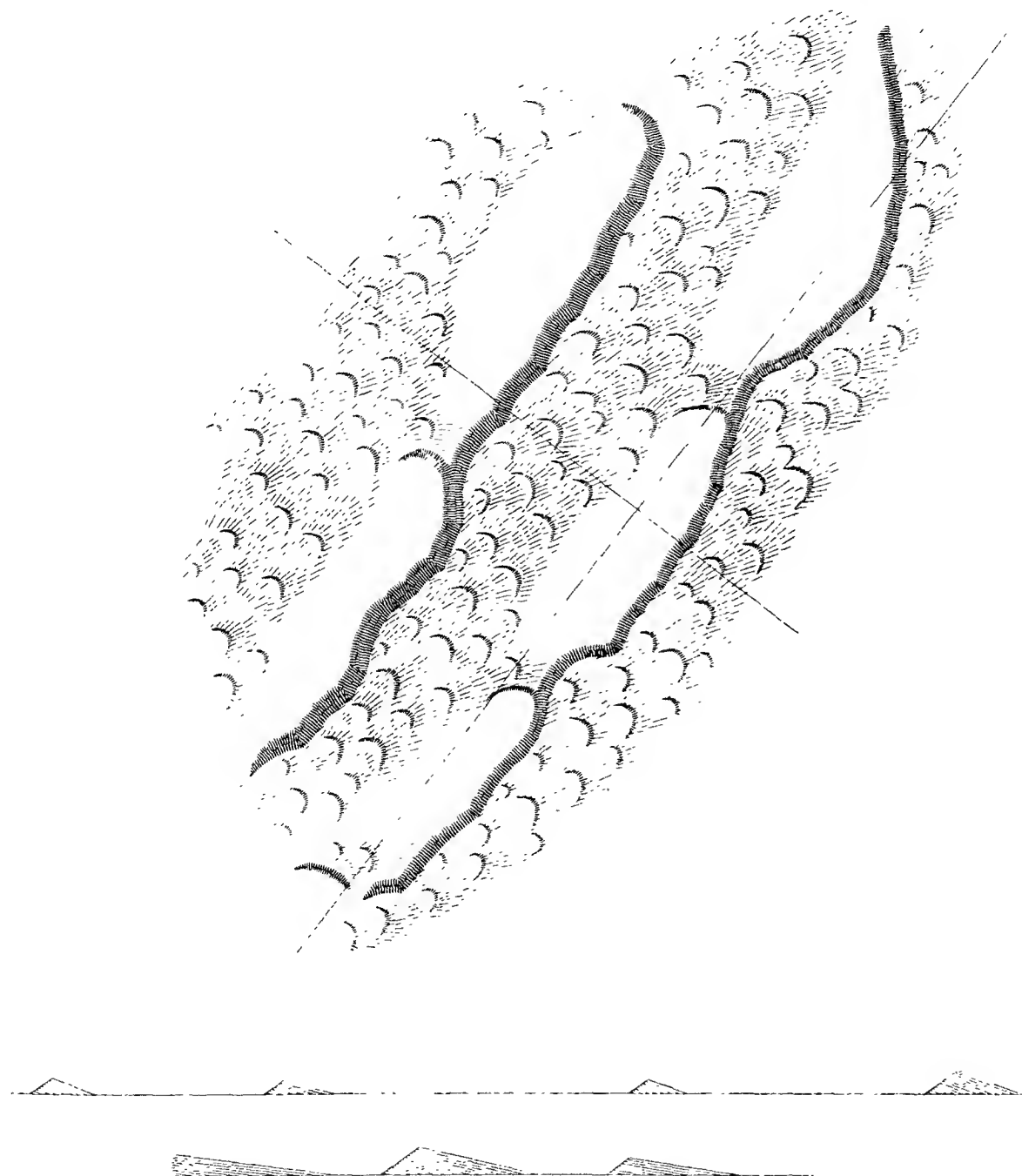


Fig. 317. SKETCH OF BAJIRS NO. 1, 2 AND 3. THE FIRST VERTICAL SECTION GOES FROM NE. TO SW., THE SECOND FROM SE. TO NW. ALONG THE TWO LINES CROSSING EACH OTHER.

elongated waves, distinctly outlined, corresponding to the breakers of the ocean. In the sand-waves the sand breaks and pours down over the leeward side; in the ocean-waves the water, too, breaks and goes over on the same side, though, as a con-

sequence of its lighter consistency, it foams as it falls, that is the wave breaks away from its crest and plunges down into the trough to the leeward. The sand-waves disseminate themselves over the desert towards the west in concentric circles, cor-

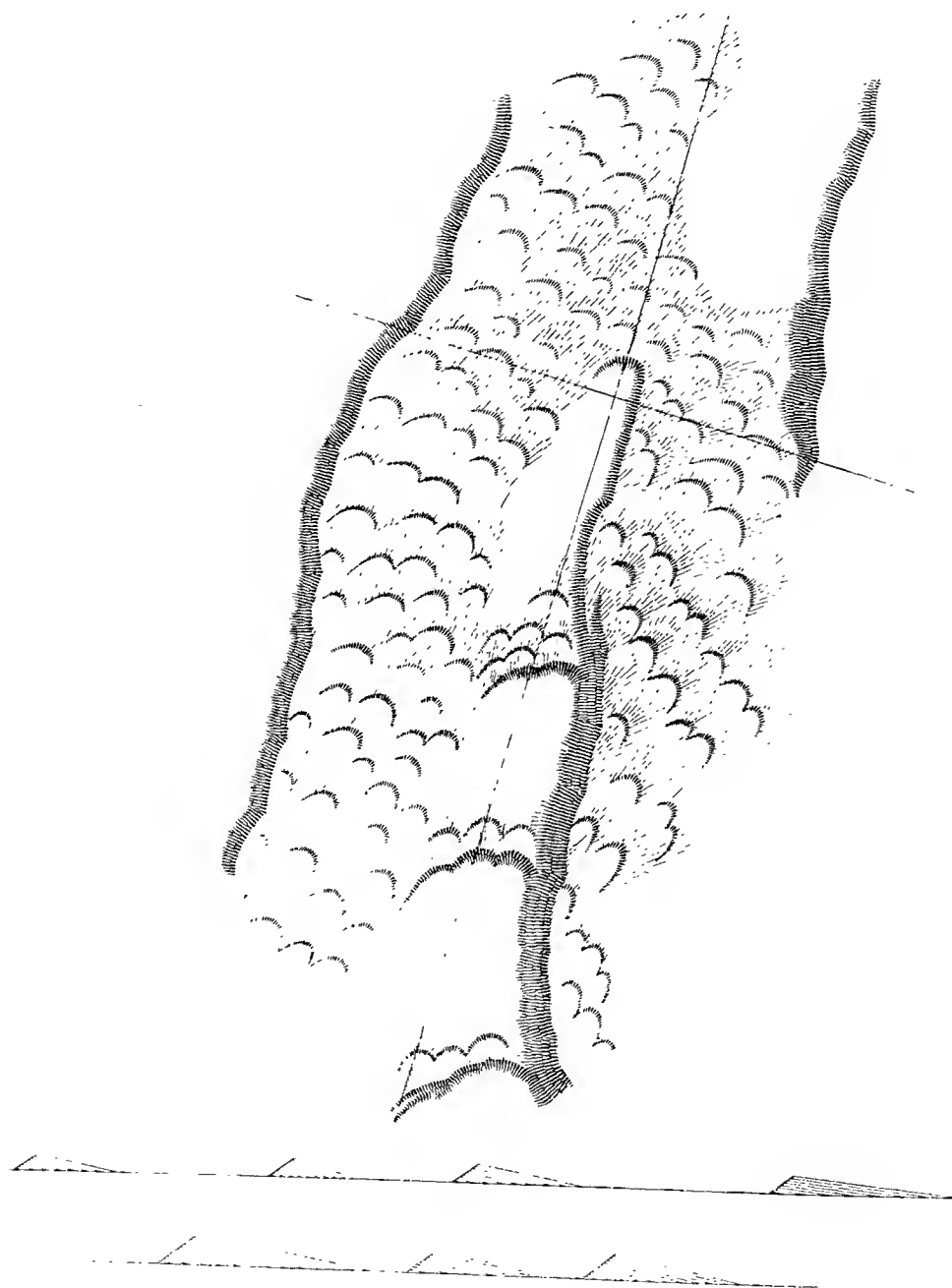


Fig. 318. SKETCH OF BAIHS NO. 15, 16, 17, 18 AND PART OF 19. VERTICAL SECTIONS FROM  
1) NNE. TO S-W. AND 2) FROM ESE. TO WNW.

responding to the ripples which arise on the surface of a tranquil pond when you fling a stone in. Here too the waves follow one another, and diminish in force in proportion as they travel away from their source, though indeed they speedily come

to an end. In order to ensure their continuance, it is necessary that several successive stones should strike the water one after the other at the same spot. This is what takes place in our desert, each succeeding windy period breathing, as it were, fresh life into the sandy waves, the only difference between them and the waves set up by the stone being that the former travel with exceeding slowness.

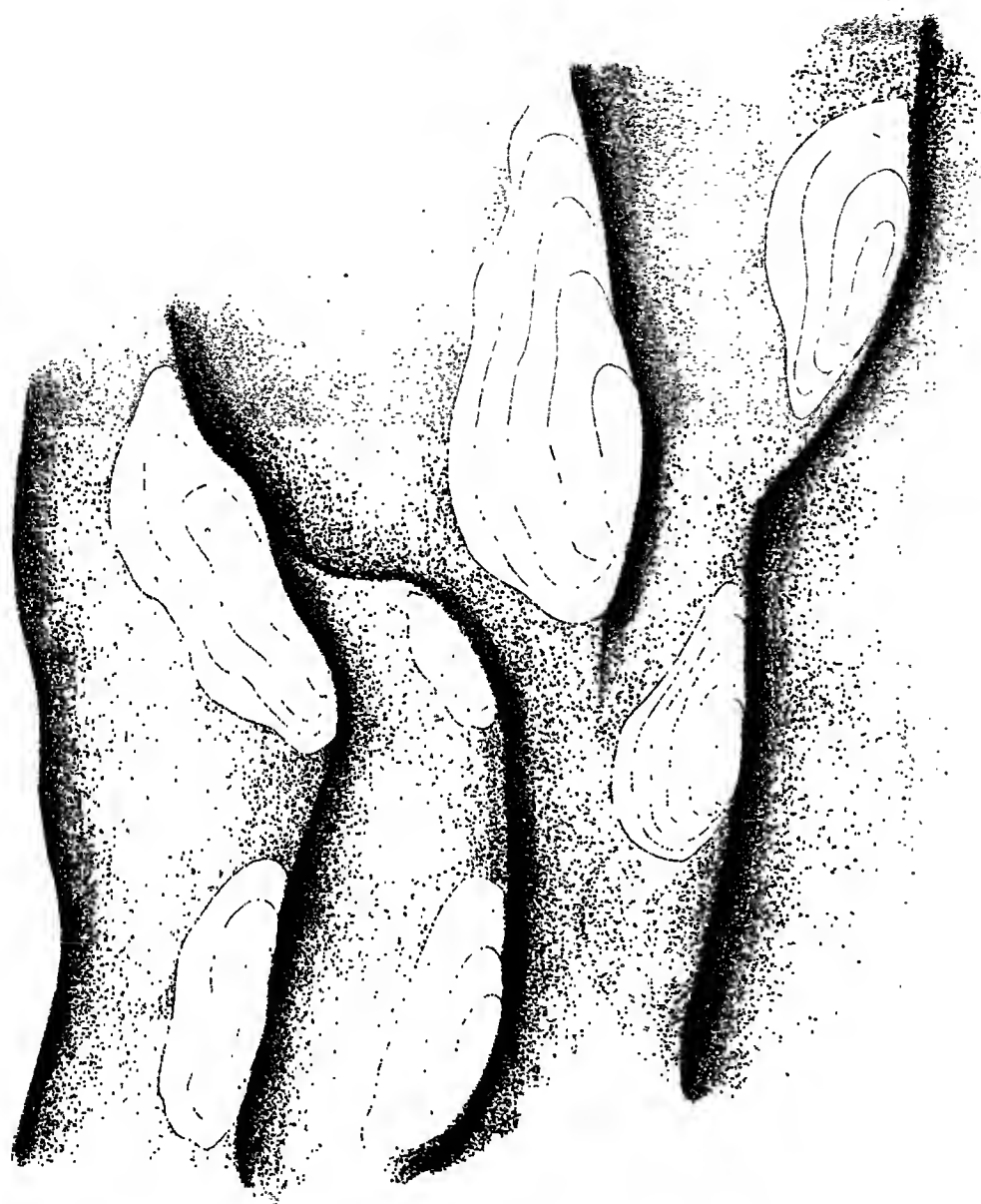


Fig. 319. BAJIR NO. 20 AND ITS IMMEDIATE NEIGHBOURS. WHERE THE SKETCH IS DARKEST THE SAND LIES DEEPEST.

But one might suppose that some time or other the transportation of sand from the east would cease, especially as the curving streams of the Tarim and the Kongsche-darja constitute an almost impassable barrier in the way of the sand of the Desert of Lop, preventing it from crossing over and mingling with the sand of the Desert of Tschertschen. And indeed, if the Tarim continues in the future to maintain

its present position, those of the desert waves which now lie closest to its right bank will gradually advance away from it. In point of fact, in the last portion of its course, approaching Arghan, we did find that the sandy desert has already moved a considerable distance to the west, so that frequently its dunes were not visible from the river, and the intervening space was occupied by a belt of steppe. Higher up however, in the neighbourhood of Jangi-köl, the river presses close into the desert, a consequence of its own migration towards the right, the stream moving at a faster rate than the sand. Nor must we forget that the lower course of the Tarim is a new creation, and that formerly the river made its way eastwards to Lop-nor; it was not until it wheeled sharply to the south that the desert became cleft in two, and the transportation of sand from the Desert of Lop ceased. This very circumstance, of the close proximity of the Tarim and the sands of the Desert of Tschertschen is a permanent proof of the correctness of my assumption, that the change of direction of the river from east to south is an occurrence of recent date. Had the stream flowed along its present bed for any real length of time, the north-east quarter of the Desert of Tschertschen would not be such as it actually is, but the sand would have been blown westwards, leaving close beside the river a broad strip of level steppe. What justifies us in arriving at this conclusion is our knowledge of the wind relations of the region. No part of the surface of the earth is so intimately and so palpably affected by the wind as a sandy desert. The wind does indeed leave its effect upon even the hardest rock. Steppes, lakes, forests — all exhibit more or less perceptible traces of its influence. But it is only in the sand that it leaves indications of its operation as plain and distinct as the footprints of the traveller who walks across it. From the form and position of the sand-dunes one may determine, as from a self-registering instrument, from which direction the wind blew last, and from which quarter the prevailing winds come.

By way of illustrating what I have just said, I append some figures. In fig. 317 we have a view of bajirs 1, 2, and 3, exhibiting the extraordinary regularity of their structure, together with a view of two other bajirs situated to the west of them, which I did not see myself, but only heard speak of. This shows us how

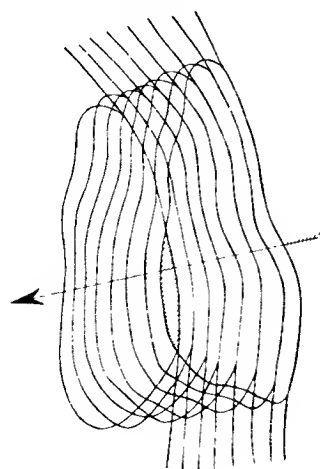


Fig. 320. ADVANCE OF A  
BAJIR-DEPRESSION TOWARDS  
THE WSW.

infinitesimally unimportant the dune-system of the thresholds is as compared with the system of the dune-accumulations in the north of the desert. The second fig., 318, shows us bajirs 15, 16, 17, 18, and 19, and how, although the great billows are quite as powerfully developed as in the north, the sand in them preponderates as compared with the bare surface of the bajirs. The next fig., 319, is of bajir No. 20 and its immediate neighbours. The darkest portions indicate the places where the sand lies thickest, that is to say on the tops of the dune-accumulations. The lighter parts represent the windward slopes; the white patches are the bajirs. Pl. 52 shows the probable extent to which the bajirs are distributed through the desert ocean. The vertical sections speak for themselves. Finally fig. 320 shows the

successive stages in the slow westward advance of a bajir depression; and from it we see that the striated portion of the bottom of the bajir must be the oldest and deepest, as I have previously shown.

Here however we must leave this desert, though in Vol. II I shall have occasion to revert to two or three of the problems connected with it.

## CHAPTER XXIII.

### A TRIP TO ANDERE-TEREM.

The short tract of country which lies between Keng-lajka and the Tschertschen I have already described in *Petermann's Mitteilungen*, Ergänzft. 131 pp. 176—178; consequently I can here pass over it briefly. We rode beside the river on the track that runs up its left bank, threading successively thin poplar groves, luxuriant kamisch-fields, and tamarisk steppes. The village (*kischlak*, *kent*) of Tattran consisted, as in 1896, of 12 *ujlik*, dwelling in simple huts of sun-dried clay (adobe), buried in toghrak, *täräk*, and *suget* (willows). A canal runs through the village, and is spanned by a bridge; and at intervals we discerned traces of older and now abandoned canals. Immediately beyond the village begins the distinctly marked *jar*, or »erosion terrace», of the river, indicating the limit to which the high flood rises. All along its base, down in the bed of the river itself, there are level kamisch-fields, the reeds standing upon dry ground, at all events at the time of our visit. And even in such places where alluvium is wanting, and the current flows close in under the terrace, there is a narrow strip of clear running water barely a meter wide. Here large numbers of wild-duck spend the winter. The opposite or right bank likewise possesses a similar high perpendicular erosion terrace. The two banks run pretty straight, and parallel, but between them the river meanders to and fro a good deal. The poplars do not form a continuous forest; but the trees are old and big, and bear witness to the river's having flowed in its present channel for a very long time.

The greater part of the town of Tschertschen lies on the left bank and consists of homesteads scattered along the canals which leave the river on that side. It is ruled by a *bek*, and is said to consist of 500 *ujlik*, as compared with 225 on the occasion of my former visit. This great increase might have seemed in the highest degree unlikely, were it not known that the Chinese, since the last Tunghan revolt in 1896, have been concerned to develop and enlarge this town, so that it may eventually become a point of strategic importance, and serve as a barrier in the way of any further Tunghan invasion of Chotan and Kaschgar from the region of Si-ning. Indeed the Chinese are talking of stationing a small garrison in Tschertschen. The bazaar did not however appear to be any busier than it was four years pre-

viously. A Chinese *sia* collects the *basch*, or »toll per head», upon all live animals that are sold, namely 3 tenge for a cow, 4 for a horse, 20 pul for a sheep, 1 to 2 tenge for each yak that is shot. The last-named item is said to yield annually 1,000 tenge, and the total duties to amount to 4,000 tenge, all of which goes to the amban of Kerija. The boundary between the provinces of Tscharklik and Tschertschen passes through Jaka-toghrak in the vicinity of Vasch-schahri. This *basch* is however the only tribute which the Chinese levy here.

On 16th January 1900 I left Tschertschen with four men and seven horses and set out upon the *astin-jol*, or »lower road», to travel to Nija. I had already traversed the upper road, which runs through Kapa and Kara-saj, on my former visit. Immediately you turn your back upon the huts and courtyards of Tschertschen, with their small fields around them, you at once find yourself in a desolate country, the soil, which is sometimes level, sometimes slightly undulating, being almost perfectly barren. The only vegetation consists in a few solitary tamarisks, each growing on its own mound. The road soon crosses an abandoned arik, now in part obliterated, and after that another one recently dug, for which reason the locality is called Jangi-östäng. Beyond that the country is absolutely sterile. The ground is covered with fine, soft dust, and the road wound like a narrow black braiding across the mantle of snow which clothed the face of the country. In two or three places we observed side-paths leading down into the desert; they are used by *otuntschis*, or men who cut the brushwood which grows on the skirts of the desert, and carry it into Tschertschen for fuel. On both sides of the road there are numerous table-topped or conical survivals of clay terraces, flat on the top and always with horizontal bedding. They consist of the same tolerably hard, light yellow clay that we found in some of the northern bajirs, and also in most of those in the extreme south. In the district of Kanscha-jantak we again encountered living tamarisks, growing on their conical mounds. After that we had on our left low dunes and on our right steppe of tamarisks, *jantak*, and similar desert scrub. North of this steppe there is said to be a stretch of *schor* or saliferous soil, and beyond that again the barren sandy desert. Next we traversed a belt of low sand-dunes, with poplars growing amongst them, not more than two men's stature in height, but often half a meter in diameter; that is to say, they were short and stunted, the stems being disproportionately massive as compared with the spread of their crowns. Beyond the drift-sand the poplars become more general. We only observed kamisch in two places. We halted for the night at the well of Kallaste.



Fig. 321. CLAY TERRACES.

On the morning of the 17th January the atmosphere was perfectly clear. The mountains to the south stood out with great distinctness, as a very sharp-cut, darker silhouette, of a greyish blue colour, their contours being pure and well defined against the sky shortly before sunrise. But as soon as the sun rose they disappeared, probably because the light which fell upon their snow-fields was of the same in-

tensity as that which lit up the sky. There was a strong rime-frost lasting all the morning, and it soon formed a gradually thickening mist. The sky, after being perfectly clear for a space at about 11 o'clock, again clouded over, and at half-past four in the afternoon the snow began to come down in thin, fine flakes. Quite a fresh breeze blew all day from the west-south-west.

It is an easy road, running through soft sand, except in a few places where the surface consists of a thin coating of clay, slightly convex, off which the sand has been blown. On the whole it is tolerably straight, winding only to avoid the dune crests when it threads a belt of dunes. The steep leeward faces of these are all turned towards the south-west, and the prevailing wind is too feeble to alter their situation in the slightest degree. Occasionally we came across patches of detritus, but in every case extremely small in quantity; it consists for the most part of round rolled pieces of green crystalline schist. These patches of débris are the extreme stragglers of the great mass which lies at the foot of the mountains, forming in some places, e. g. at Kapa, accumulations of immense thickness.

At first our route lay amongst small dunes and scattered mounds. At Ketme, where the surface becomes covered with small granulations and scrub (*jantak* and *tschige*), there is a well. The true name of the place is apparently *Kertme*, a word which is stated to signify »hard clay terrace», or a step-like formation of the ground. The well, *Ketme-kuduk*, is situated in a hollow, an erosion trench, which, according to *Roborovskij's* statement, is an »old bed of the river *Tschertschen-darja*». My guides however asserted distinctly, that it is a continuation of the watercourse which is formed by the streams *Atschan*, *Isängän*, and *Kontsche-bulak*. It is the rarest thing in the world, they said, for its water to get as far as the *astin-jol*; though the existence of the watercourse would seem to indicate that at one time at any rate it did do so, even though it were only once in a decennium after an especially heavy rainfall in the mountains. I consider it extremely unlikely, that it ever was a former bed of the *Tschertschen-darja*. It is quite certain that in *Marco Polo's* time *Tschertschen* was situated where it now stands, and in 600 years an old watercourse like that at *Ketme* would have been obliterated. In the actual bed there still remain several table-like elevations of hard grey clay, cubical or oblong in shape, and resembling at a distance houses and walls. It is perfectly evident that they were at some time or other eroded by the heavy floods of water which rolled down this channel.

After riding for some distance beyond *Ketme* through low sand, dotted over with *tamarisk*-mounds, we entered a region of absolute barrenness. The surface is very gently undulating. The sand is coarse-grained, but is arranged in broad, low waves, so low indeed that we were often only aware of their crests by noticing that the snow had melted off them, thus giving the country a black-striped appearance. The steppe again makes its appearance at *Jantak-kuduk*. Southwards from that point it is said to be no very great distance to the barren sand, though on the north the sand is a long way off. The wells were all frozen; but we had no need of them, there being a superabundance of snow. The water in them is said to be almost fresh, although they are only 1 to 1½ m. deep. They are so constructed as to be protected on the south by an overhanging shelf, whilst there is a convenient approach to the water on the north. Several of them were however then half-

filled with sand and dust, and would have to be cleaned out before they could be used again. On the other side of Jantak-kuduk poplars and kamisch are tolerably general. The low dunes still continued quite close in on the left hand, whilst on the right, or to the north, there was a dark belt of *tokaj* or brushwood, bushes, and poplars. The well of Ak-baj-kuduk was perfectly usable. The district beyond it, in which we encamped, is called Ak-bajning-kasch.



Fig. 322. VERTICAL SECTION OF AN ORDINARY WELL.

January 18th. The snow came down faster, and the fall during the night was rather heavy. The fresh-fallen snow lay at first like cotton-wool upon the older harder snow, filling up every crevice. During the day however the greater part of it disappeared, though the old consolidated snow still remained. A more monotonous and dreary landscape it would be hard to imagine. Although hares and wolves were reported to be numerous in the locality, and the snow was plentifully marked with their footprints, we did not see either animal, nor did we catch a glimpse of a single raven. The vegetation is equally monotonous; the commonest being tamarisks, and after them come kamisch and toghrak. At Lenger-dung there are a few poplars, growing round about two or three detached conical hills. After that comes kamisch steppe; in the neighbourhood of Tajlak-tutghan the kamisch is pretty thick and luxuriant, and the ground it grows on is partly level, partly lumpy. The name I have last mentioned is of some interest, in so far as it points to the former presence of the wild camel; and this animal, my guides asserted, did formerly frequent the locality. Beside the well of the same name, there is a small poplar grove. Wells without names are quite common hereabouts; they are dug by travellers faring along the road in summer. The ground-water is everywhere so close to the surface that it costs very little trouble to quench your thirst in this way, if the next known well is some distance farther on.

On the other side of Tajlak-tutghan the barren sand approaches quite close to the road, and it accompanied us on the left hand all day. Sometimes we would cross small projecting tongues of it, then again it would recede, and give place to thin forest. As far as Osman-baj-kuduk the road continues along the edge of the sand, whilst on the right, that is to the north, we have kamisch steppe, with an occasional tamarisk mound. The belt of dunes, which extends southwards between the astin-jol and the detritus slope at the north foot of the Astin-tagh, is completely separated from the great sandy desert of the north. A vertical section taken along a south-north line shows, first bare rock, then in succession the gravelly *débris*, soft earthy hills covered with grassy vegetation, loess steppe, bare and barren *saj*, dunes, a forest-belt, and in the extreme north the great sandy desert, extending all the way to the Tarim. Hence we may speak of a definite belt of vegetation in the desert. Both the southern belt of dunes and the region of vegetation which lies to



the north of it are traversed by the rivers Kara-muran, Möldscha, Bostan-toghrak, Tollan-chodscha, and Nija-darja, some of these being at times very respectable streams, although, like all the rivers of East Turkestan, they are undergoing a process of shrinkage. In former times they were all bigger and watered more plentifully the region in which vegetation is growing; though this is now dying out and thriving ill, and will no doubt in due time be overwhelmed by the sandy ocean advancing from the north-east. The strip of fresh grazing which lies at the foot of the detritus slope of Kirk-saj, and on which the *taghliks*, or »mountaineers», graze their sheep, is mainly watered by rain, and some smaller streams. Below this strip of grazing comes the saj, which possesses every condition requisite for the formation of a desert — refractory soil, hard gravelly débris, and scanty precipitation. The rivers I have named, although they cut their way across this belt, do not in the slightest degree do any-



Fig. 323. A CARAVAN OF MERCHANTS FROM KERIJA, TRAVELLING ON THE »ASTIN-JOL».

thing to water it, for they have excavated for themselves such deep and well-defined channels that, even when they rise exceptionally high, they are unable to overflow, and so confer benefit upon the adjacent districts. The water flows as it were through underground drains or conduits, and the saj derives not the smallest advantage from it, and consequently remains barren. The same thing is true of the belt of dunes which lies below it; for although the rivers there flow along shallower beds, they are of no service to the soil. But in the belt of vegetation beyond the astin-jol the case is quite different: there the river-beds are barely sunk below the level of the general surface, but spread themselves out in a deltaic manner, and so moisten the ground, which has an extremely gentle inclination towards the north. It may be assumed, that when these streams carried bigger volumes than they do to-day, there was in this part of the country a very extensive forest, which effectually kept the desert at bay. Perhaps the belt of vegetation which we crossed in the middle of the Desert

of Tschertschen had some connection with it. But the dunes have gradually encroached upon this former steppe and forest region; and considering the gradual diminution in the water-supply, it is easy to foresee, that what little now remains will eventually be overwhelmed by the sand. And as it is certain that the greater part of the immense quantities of sand which fill the Desert of Tschertschen and the Takla-makan emanate from the mountains that shut in East Turkestan on the north, so may it be assumed that the small strip of desert which lies south of the astin-jol owes its origin to the disintegration of the mountains which form the southern girdle of the region.

On the other side of Osman-baj's well the road winds through a perfect labyrinth of high, regularly formed tamarisk-mounds, as if it were threading a hollow cutting. The bushes are in part dead — there is here an almost inconceivable quantity of dry fuel — in part living, these latter small, but growing tolerably close together. The soil consists of sand — it was then moist — and in some places there are dunes amongst the tamarisk-mounds. There is a bare depression resembling a former channel of the Kara-muran, or it may be a side-channel, that fills sometimes when there is an unusually large volume of water. The main channel was at that time absolutely without either water or ice, but was buried under snow; it was not very deep-cut, being only 1 to 2 meters deep, and was bordered by clay terraces at different levels, showing that it had been traversed by floods of different volume. Its breadth was probably 70 to 100 m., and so far as we could see it, and that was not far, for it was soon hidden behind the tamarisk-mounds, it came from S. 20° E., and proceeded N. 20° W. In the summer it is said to carry an abundance of water, which however comes down intermittently, or in irregular floods, according as the rain or snow falls in the mountains. The clay terraces which border it are of sedimentary origin, and consist of fine, grey clay, deposited horizontally; but it is not fluvial alluvium, because clay of a similar character is found all the way beside the road, generally in the form of detached tables or »logs», with horizontal layers of varying thickness and hardness. Both material and consistency are precisely the same, and so too is the naked soil that crops out between the dunes. In the southern dune-belt the river is said to wind a good deal, and in the saj its channel to be deeply cut.

The tamarisk-mounds are quite as numerous on the west of the river. Seeing them growing in this way, one is almost induced to believe that their formation is in some way or other connected with running water. The fact of their being most numerous beside the river may be accidental, or a consequence of the more plentiful moisture, for tamarisk-mounds are found practically all over the southern part of the sandy desert, sometimes in small groups, sometimes occurring singly. Presumably they owe their origin to wind erosion, being held in place by the roots of the tamarisks when the surrounding loose material is blown away.



Fig. 324. VERTICAL SECTION OF THE KARA-MURAN.

As we approached the well of Tschingelik, the tamarisks began to thin out, and poplar forests became common, being often dense and tangled. The name of our camp was Toktäk.

On the 19th January the road still continued to run along the border-line between the sandy desert and the zone of vegetation. To the south high sand, to the north steppe, with occasional poplars. At Paka-kuduk we found a shepherd, with 300 to 400 sheep and some cows. He possessed a hut, which however he only occupies in winter; for in the summer he is accustomed to graze his flock in the neighbourhood of Andere-terem. This locality, situated on the lower course of the Bostan-toghrak, would appear to have been formerly a place of some importance, for all the shepherds, who now frequent the Kara-muran and the other rivers in the vicinity, are said to have been born there. And until 7 or 8 years ago, when the place had to be abandoned because of the quantity of mud the river brought down, wheat, maize, and melons used also to be cultivated there. Since the date indicated the river has dwindled. At Jar-tongus, on the lower course of the Tollan-chodscha, two days' journey below the Nija road, there were still four families remaining. At Kara-muran there were said to be three shepherds' families about one day's journey below the road; and from that spot it is reckoned another day's journey to the edge of the great sandy desert. All this region is reported to suffer from the stifling heat in summer, and gnats, mosquitoes, and gad-flies are an intolerable plague. The spring and early summer are said to be the season of the winds; and kara-burans are frequent. The prevailing winds come from the north-east and east-north-east.

After that the steppe continues as far as Schudang, where we again found shepherds. The well at this place, which is 3 m. deep and yields fresh water, is situated in a depression, through which one of the arms of the Möldscha-darja has certainly flowed at some period. Close beside it stands a *lenger*, or »rest-house», built four years previously by command of the Chinese. The actual river-bed is bordered on the left by a very distinct erosion-terrace, on which there is a poplar forest of tall, fine trees, interspersed at intervals with dense thickets of tamarisks. Here too there are some (eight) huts, roofed in with beams and kamisch. They have been built because the Amban of Kerija is desirous of seeing the district *abad*, or »inhabited», and certain families in Nija and Kerija were ordered to come and settle here, and cultivate the soil. After the ground was duly prepared, and canals dug from the Möldscha, the seed was sown; but the very first year the crop proved a total failure, owing to the water from the mountains arriving too late. At Schudang the Möldscha is said frequently to shift its bed, and inundate first one part, then another of the forest. It is strange that this river, whose upper course flows in so deeply grooved a channel, and which so frequently possesses an abundance of water, should here, at a distance of only 80 kilometers, be so small and insignificant. The beds of the Bostan-toghrak and Kara-muran are both much more developed, and probably therefore reach farther to the north, before they succumb in their struggle against the sand. There are generally three or four plentiful overflows every summer; indeed these are sometimes so copious that the road is stopped for one or two days. But there is always *kara-su*, or »spring water», to be had. The main high

floods are called generically *ak-su*, or »white water«, because they are fed by the snow, and are turbid; or else they are known as *sil-su*, or »overflow water«. There are said to have been wheat-fields a little below Schudang, near the Möldscha, but they had to be abandoned because the water was unable any longer to get down to them.



The vegetation on the way to Tschaltschik on 21st January was a good deal more abundant than before, especially poplar woods. At the same time the kamisch-fields were numerous and vigorous. It was but seldom that we saw low dunes. Kamaghas is bordered on the south by tolerably steep dunes, with sometimes a small toghrak, while on the north rises a terraced hill, with a rest-house built four years previously; and between the two there is a little hollow with springs in it, forming a reedy marsh or pool, which was at that time frozen over. However, good water may be obtained from a shallow well. A little hill to the left is crowned by the masar of Schejtlar, with its *tugh* poles. At Tschaltschik there is a shepherd's hut. It snowed smartly all day, and all the following night, the wind blowing from the south-east.



Fig. 325. THREE VIEWS OF THE HUTS AT SCHUDANG.

Quitting the road on the 22nd January at the masar, we turned our steps towards the north-west, making for a spot known as the *kona-schahr*, or »old town«, the real object of the excursion. The poplar forest came to an end shortly after we left camp, and we then had an extremely disagreeable and difficult ground to reckon with, namely a perfect labyrinth of tamarisk-mounds, with living bushes on the top of them, and dead ones on their sides, while in between them was another labyrinth of low dunes. Every now and again the characteristic

terraces of hard clay cropped up. Of poplars there were none. In the midst of this desolate scene we found the tolerably well-preserved wall of an old house, the plan of which is reproduced in the annexed sketch (fig. 326). The material of which it was built consists of hard tenacious clay, plastered on to a framework of beams. The wall is in most places 3 to 4 m. high, though at its highest it measures 5.8 m. At *a* there is a staircase leading to the top of the wall; and *b* and *c* represent small orifices in the walls. Small fragments of red burnt brick lay scattered about the interior. On the east there is a high tamarisk-mound, growing in close intimacy with the outside of the wall. The walls are 2.80 m. thick. The interior forms very nearly a square, its dimensions being  $13.35 \times 13.90$  m. At the south-east corner there exist traces of yet another old wall.

That evening we encamped beside the ruins of a wall which appeared to have been once very substantial, and stretched from S.  $10^{\circ}$  E. to N.  $10^{\circ}$  W. It really consisted of two thin walls, standing parallel to one another, the space between them being filled in with earth and dust. In the vicinity are other ruins of similar walls, but in an advanced stage of decay. I did not succeed in finding a house; but our search was unfortunately greatly hampered by the snow, which lay a foot deep. There is however the bottom portion of a round *potaj*, surviving up to the height of two or three meters. Towards N.  $30^{\circ}$  E. there extends an old river-bed, 20 m. wide, with distinctly marked clay escarpments; possibly it is an old arik that issued from the Bostan-toghrak or Andere-darja on the right. On its right-hand side stands, on a clay hill, a tower (*gumbes*), 10.5 m. high and 24.2 m. in circumference; the last measurement was taken at the man's feet on the accompanying illustration, fig. 327. The tower is round and solid, and is built as usual of sun-dried clay. Towards the top there is an aperture, through which access can be obtained to the summit. The tower possesses no door, though lower down, at *a*, there is, it is true, a hole; but it appears to have been excavated by somebody desirous of investigating the interior of the edifice.

*Hedin, Journey in Central Asia.*

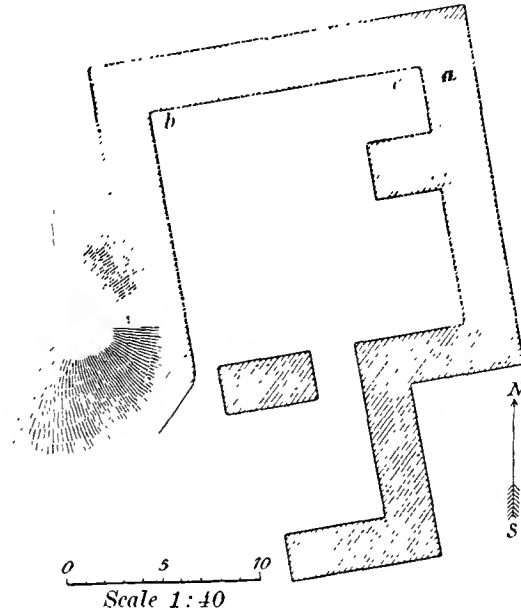


Fig. 326.

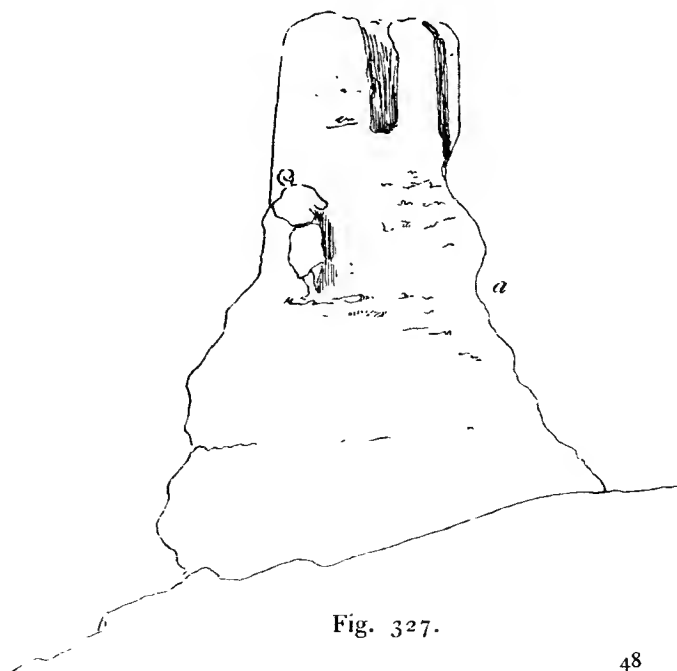


Fig. 327.

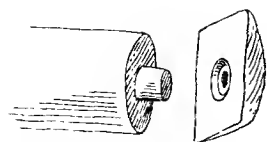


Fig. 328. FRAGMENT OF  
A BEAM.

Close by we picked up fragments of black and red pottery. Looking from the top of the tower towards the south-west, we descried an almost sterile country, except that an occasional tamarisk showed itself amongst the low dunes. Northwards the vegetation gradually died away as it approached the barren sand, but we were unable to see the lofty dunes. Andere-terem is said to be already encircled by high barren sand on the west, north, and east — *kisil-kum* the shepherds call it. In the S.  $42^{\circ}$  E. there appeared two other *gumbes*. The only »find» I made in the course of a superficial investigation was a door-lintel.\*

Through the fast-falling snow and over the same hateful ground we now rode south-west towards the bank of the Bostan-toghruk. As we approached it, the sand diminished in quantity, but on the other hand the tamarisks, still on their mounds, continued to increase in number. In some places their mounds stand extraordinarily close together, and are high, and sharply outlined; but after a while they become lower, and finally the tamarisks form impenetrable thickets growing on the level ground. Then comes a belt of dead poplars, the trees, although withered, still standing upright upon their roots. But along the right bank of the river there are tall, living poplars.



Fig. 329. VERTICAL SECTION OF ANDERE-TEREM AT KÛRTSCH-AGHIL.

The river wears here an unexpected aspect, being as large and as sharply circumscribed as ever the Kerija-darja is, and it was then full of ice and snow. The right bank is very steep, and has at its foot a low, level strip of »shore», barely one meter above the surface of the ice. Here there is a sprinkling, but a thin sprinkling, of fine old poplars, and kamisch is plentiful everywhere. A solitary shepherd's hut, standing on the strip of shore just mentioned, seems to indicate that this is no longer overflowed by the river. The ice in the river consisted of several layers caused by the spring water, which had been flowing all winter, freezing in cakes, so that the ice had in this way grown thicker and thicker. The ice-sheet was said to reach all the way to Andere-terem, which, from the direction pointed out to me, lay N.  $30^{\circ}$  W., and was a day's journey distant. On Roborovskij's map the distance between Andere and Andere-terem amounts to 115 km., on Stein's map to 61 km.; the latter is undoubtedly the correct figure. On the whole I am inclined to think that the river does not extend so far below the astin-jol as it is made to do on Roborovskij's map, nor is the belt of vegetation so broad as he makes it appear. As I have stated, we were able to see the end of it from the Kona-schahr, and noted how it was succeeded by barren sand. I believe rather that there is a great resemblance between this river and the Chotan-darja and the Kerija-darja, and that as there are tracts of desolate sand between these two rivers so

\* For the interesting discoveries made by Dr M. A. Stein at this identical place, see his *Sand-buried Cities of Khotan*, pp. 409 ff.

in like manner there exists a belt of desert between the Bostan-toghrak and the Möldscha, and that it is only for a little way below the astin-jol that it is interrupted by the belt of vegetation. Of course the rivers here, like the Chotan-darja and the Kerija-darja, are accompanied by vegetation as far as they penetrate towards the north. It is also likely that, as they near their terminations, they incline, just as the Kerija-darja does, towards the north or north-east; for of course the entire basin of East Turkestan slopes towards the east, that is towards Lop-nor.

In the locality of Kürtsch-aghil, where we encamped, the river, or rather the sheet of ice, was 141.5 m. wide, but appeared to contract both above and below that point; the low strip of »shore» was 126 m. across. The scarped bank on the left was vertical, and 5 to 6 m. in height, while that on the right was 7 to 8 m. high. Thus the total breadth between banks amounted to 267 m., and evidently the bed was formerly at times filled with water. The part of the bed which was then covered with ice is no doubt in due season filled with an active current. No doubt too it makes, as the Kerija-darja does, a more imposing appearance in winter than in summer, owing to the development of the ice-sheet. Hewing a hole in the ice, we found that it was 0.46 m. thick, and rested directly upon the mud at the bottom. It is said to remain  $3\frac{1}{2}$  months altogether. When it thaws in spring, a *mus-suji*, or »ice-flood», is originated, which for some days carries a considerable quantity of water past Andere-terem and becomes lost in the sand half a day's journey farther north; but beyond that it never penetrates. Poplars and tamarisks continue as far as Andere-terem, but no farther. At the spot where the river encounters the high sand, there is said to be no vegetation, though this is doubtful. After these spring freshets have passed the only water that the river contains is such as is yielded by the perpetual springs. In summer the *ak-su* is stated to flow for three months, beginning early in June. The same conditions apply in the case of the Tollan-chodscha, except that this river is said to penetrate three day's journey north of the astin-jol. At Andere-terem the configuration of the river-bed is stated to be pretty much what it is at Kürtsch-aghil, that is to say a broad bed, with sharp-cut banks, and a narrow strip of low soil below them. It is on one of these low strips that the deserted fields are said to have been. They were watered by tiny irrigation canals, coming directly from the river, and being inundated during a flood of unusual dimensions, were buried under the mud.

Between Kürtsch-aghil and Andere-terem there are only two localities that bear names, — Kara-ötschke-ölturghan, or where the Black Goat was Killed, and Tar-



Fig. 330. LEFT BANK OF BOSTAN-TOGHRAK.

kum (pronounced *ta'kum*), or the Narrow Sand, i. e. the narrow passage between the dunes, an especially significant name, proving as it does, that in this locality at any rate the river flows through a belt of dunes, and not through an unbroken forest, as one would suppose from Roborovskij's map. Generally, his details are quite trustworthy where they are entered from his own personal observation. There are several parallels to this Tar-kum beside others of the rivers of East Turkestan; *e. g.* Jughan-kum (Big Sand) beside the Kerija-darja, Jaman-kum (Horrid Sand) beside the Tschertschen-darja, Tokus-kum (Nine Dunes) beside the Tarim, Tagh-kum (Mountain Sand) beside the Ettek-tarim. In each of these localities, and there are many others, patches of bare sand have advanced quite close to the river.

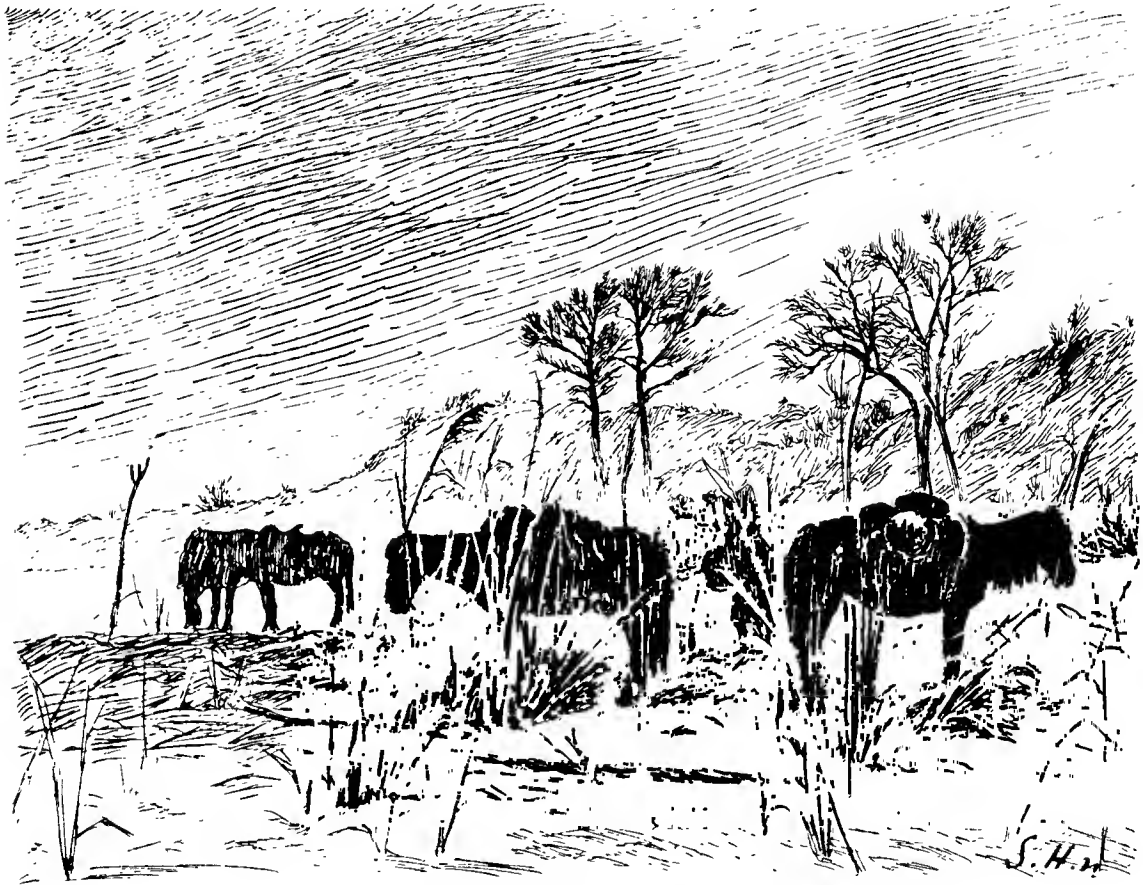


Fig. 331. KURTSCH-AGHIL.

The Andere-darja is said to curve to the north-east before reaching Andere-terem, and so too does the Tollan-chodscha; in fact these two streams flow generally parallel to one another. The journey between Jar-tongus-terem and Andere-terem is said to be done by a mounted man in a day. At the former there are ten shepherd families dwelling, who cultivate wheat and maize on the level alluvia between the river-banks. Poplars are reported to accompany the Tollan-chodscha as far as Jar-tongus.

On the 24th January we rode along the track which ascends the left bank of the stream, winding in and out amongst tamarisk-mounds, open fields of thick ka-



misch, and fine poplar groves. In places the ground is somewhat broken, and there are hills round the fields. The river, making a bend to the east, becomes lost to sight for a good hour. At Tokus-köl there is a salt pool, fed by the infiltration of water; and beside it stands a hut. At K  k-jantak there is another hut, cosily and comfortably situated amongst some magnificent poplars by the river-side. Another satma on the right bank is called Kok-kapa. At the point where the Nija road crosses the river, the bed of the latter lies about 15 m. below the general level, and down below on the left side stands the *lenger* of Andere. Here, as also at K  k-jantak, there was a lively current running, amounting probably to 3 cub.m. in the second, but the water was not clear. The springs are reported to be situated a little way south of the road. Here too there were sheets of ice in the river-bed, though the »cake» formation begins properly speaking lower down at K  k-jantak. The deep-cut, but meandering, channel is here not half so wide as at K  rtsch-aghil.

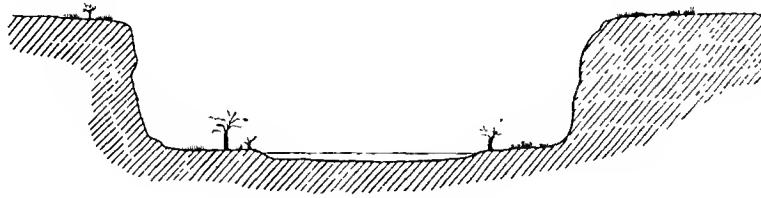


Fig. 332. VERTICAL SECTION FROM THE POINT WHERE THE NIJA-ROAD CROSSES THE BOSTAN-TOGHRAK.

We encamped in the district of Baba-k  l, immediately east of the well of the same name. The snow lay foot-deep, and it still continued to snow a little. That winter there was said to be on the whole a greater quantity of snow than usual. In the summer a fine rain falls sometimes. From this point we failed to perceive the sand to the south; but then the belts of vegetation are broader beside the rivers.

At Kamaghas we once more struck our old route, which we followed until we came to Tschertschen. The night of the 27th—28th January was the coldest we experienced that winter, the thermometer dropping to  $-32^{\circ}.2$  C.

## CHAPTER XXIV.

## THE LOWER TSCHERTSCHEN-DARJA.

In the present chapter I propose to describe our return journey down the Tschertschen-darja, and to indicate the characteristics of the physical geography of its lower course. I have already described before what is to be seen from the great highway that follows the left bank of the river between Läschkär-satma and Tschertschen, and therefore say here no more than is absolutely necessary about it. My reason for choosing the left bank below Läschkär-satma was that Captain Roborovskij had travelled on the right bank.

On 30th January 1900, then, we left Tschertschen, and crossed the river, which was covered with thick ice, except for a couple of narrow strips where a current was flowing of together 2 cub. m. in the second. It was evident that the greater part of the river was frozen to the bottom; which consisted of coarse sand and fine gravel. At the ford the river is divided into two arms; the smaller one, on the right, rises at Kumdan in the vicinity. The area enclosed between the two arms is as usual called Araltschi. Other names which we encountered during the day's march were Jak-akkan, Kum-saghilghan (the Gliding Sand), Tallik-tokaj, Ak-schor, Tschong-köl, Toghrak-aghil, Tägirmän-baschi, Jar-aghil, Ak-basch-tokaj, Usun-köl, Ak-tiken-dung, and Tschaval-dung. Several of these names are common to both banks. But there are others which only apply to the road along the left bank; these I have cited in *Petermanns Mitteilungen*. On the whole, there is a close resemblance between the two banks. At first the sandy desert which extends south of the Tschertschen-darja lay immediately on our right, but its dunes were as a rule clothed with vegetation. Every now and again we crossed small tongues of the sand. I was unable to discover any general name for this desert; the names which Roborovskij has entered on his map possess no significance in this regard. For instance, his Jakaking-kum, which ought properly speaking to be Jak-akkan-kum, must have been used by some guide in default of any better name to give; it really means only that portion of the desert which lies nearest to Jak-akkan, just as other portions are called Tallik-tokajning-kum and Jar-aghilning-kum. Asiatics have no idea of geographical provinces, or of giving them general names. Each knows his own neighbourhood only: the shepherds who roam about the vicinity of Jak-akkan know only of Jak-akkan-kum. The only exceptions

to this are the administrative provinces, the name *Alti-schahr* or *Jäti-schahr* for the whole of East Turkestan, the name *Lop*, and the names of the rivers. But, on the other hand, the mighty range of the *Kwen-lun* has no Turkish name: *Tokus-davan*, *Astin-tagh*, and *Arka-tagh* apply only to separate parts of it.

But the sand soon retires from the river, making way for steppe. On the right there is a terrace, marking a former position of the right bank. The road touches repeatedly the windings of the river. The existing right bank is very distinctly scarped, and generally about 3 m. high, and below it lies the low, flat river-bed, overgrown with *kamisch*, through which the river winds. Marshes and lakes are quite common, though all were frozen over, buried under snow, and frequently overgrown with reeds; one of these was the *Tschong-köl* named above. Every now and again the river hugs one or other of its banks, and in such places it was still free from ice. On the right we passed the little lake of *Usun-köl*, which sends off an easily recognisable arm to join the river, though it was then dry. The region is poorly supplied with dry fuel, yet such as it is, it is collected and carried to *Tschertschen* on the backs of donkeys.

On 31st January there was a violent north-east wind, which decidedly made itself felt, for the temperature never rose above  $-11^{\circ}\text{C}$ . The path runs close beside the river, following all its windings, so that it is somewhat longer than the road on the left bank. We were no longer able to see the southern sandy desert; but we could see very distinctly the scarped terraces or containing banks standing ten or twenty meters back from the existing lower banks. *Tamarisks* and *kamisch* are abundant, but *poplars* both few in number and widely scattered. The localities with names are *Baliklik-köl*, *Issik-otak*, *Supa-dung*, *Kara-kürütsch-aghil*, *Pakpak-toghrak*, and *Kischlak-aghil*. During the day we passed some dry ravines, which are said to drain marshes situated farther south, and which are in their turn formed by temporary streams coming from the mountains. At *Kona-tatran* we crossed the river, which was 120 m. broad and frozen to the bottom, so that we were unable to obtain any water for our supper except by melting ice. The village I have just named was deserted eighty years ago, because the river water would no longer flow into its irrigation channels; the ruins of four of its houses are still standing. At the place where we crossed the river, in order to encamp on the same spot as before at *Keng-lajka*, the right bank was 2 m. high, and the left bank had a gentle slope.

The problem which I set myself whilst thus returning to our head-quarters at *Jangi-köl* was to look for the old bed of the *Tschertschen-darja*, that *Roborovskij* speaks of. With this object I engaged a couple of trustworthy guides, whose first business it was to explain the presence of the two old river-beds we had crossed. They told me that the more southerly one joins the river immediately below *Keng-lajka*, while the more northerly one continues to the region of *Su-ösgen*. The latter is said to originate in the district of *Japtschanlik-köl*, a lake situated about one *potaj* below *Tägirmän-baschi* (between *Tschertschen* and *Tatran*), and about  $1\frac{1}{2}$  km. from the river; it is fed by springs, which in turn derive possibly from irrigation-canals that issue from the *Tschertschen*. My guides knew of no old watercourse on the left of the river below *Su-ösgen*; it was all sand. I had originally intended penetrating a few days into the desert, but abstained, partly because of the camels, partly because of

the information I received, which made it extremely unlikely that any old river-bed existed, except those we had already become acquainted with near the Tschertschen-darja. This river has indeed changed its bed, but it has done so only locally and within narrow limits. As Tatrau lies at an altitude of 1180 m. and Jangi-köl at 880 m., the river would naturally have flowed in this direction, did not the Kara-koschun lie at 867 m., so that the greater fall points towards this last. There is also a very appreciable fall between the foot of the mountains and the river: for instance, from the point where the Tschertschen-darja issues from the mountains to Tschertschen it amounts to 1200 m. Thus the channel which this river has cut through the desert is deeper and more definite than the bed of the Tarim, and consequently is not subject to such great oscillations as those which affect this latter. Roborovskij's statements, about the old river-bed in the desert 65 km. north of the existing Tschertschen-darja, had led me to deduce a parallelism between this stream and the migration of the lake of Lop-nor to the Kara-koschun; but after visiting the region myself, I must perforce abandon the idea of the Tschertschen-darja's migration. Yet I cannot claim that I have completely solved the problem. For a complete solution a fresh crossing of the desert is necessary, namely from Begelik-köl to Läschkär-satma, for there is just a possibility that there does exist some old river-bed in the desert, and that it may now be for the most part buried under the sand. In the sequel I shall have to return to this question again.

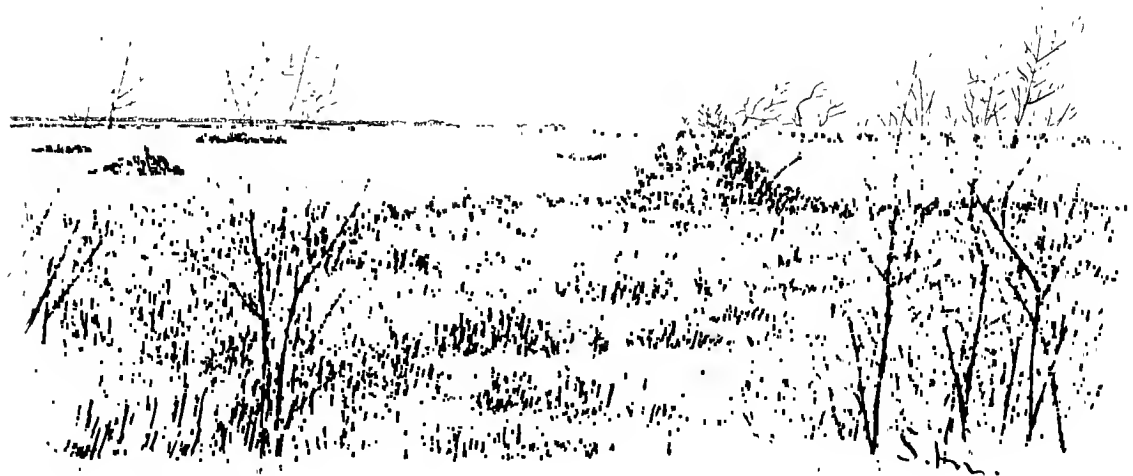


Fig. 333. THE TSCHERTSCHEN-DARJA AT KENG-LAJKA.

The ice which covered the Tschertschen-darja was expected to continue for another two months. When it breaks up it gives rise to an imposing spring-flood (*mus-suji*); and although this augments to a noteworthy extent the volume of the lowest Tarim, it is only for a short time, and in spite of this the Kara-koschun goes on steadily diminishing. The spring-flood is followed by the high flood of the middle of summer, caused by the melting of the snow in the mountains, and then for a season the volume swells to such a prodigious extent that the river is impassable. This increment enters the Kara-koschun just at the time when the inflow from the Tarim is at its minimum.

February 2nd. The bed which begins immediately below Keng-lajka terminates at Atschi-schipang (fig. 334); it is however an old boldschemal rather than a river. From the point where it reunites with the Tschertschen-darja two small ariks go off to the Jangi-terem, or »new settlements», at Atschi-schipang, where not long ago an attempt was made to grow wheat. The canals are crossed by small bridges at the point where they are intersected by the road between Tschertschen and Tscharklik. After that we left on our right the river and the little pool of Schor-köl, which, although fed by fresh



Fig. 334. PART OF THE OLD RIVER-BED AT ATSCHI-SCHIPANG.

springs, nevertheless contains salt water, and inclining to the north-north-east, entered an almost inextricable labyrinth of tamarisk-mounds, reeds, and dead forest, before we reached Tschong-schipang, the farther of the two old river-beds. This we found to be very distinct, forming an almost straight trench in the ground, with a breadth practically equal to that of the existing Tschertschen-darja. Its scarped terraces, about a couple of meters high, are crowned by a quantity of tamarisk-mounds, which help to give great definiteness of outline to the river-bed. At intervals there are poplars,

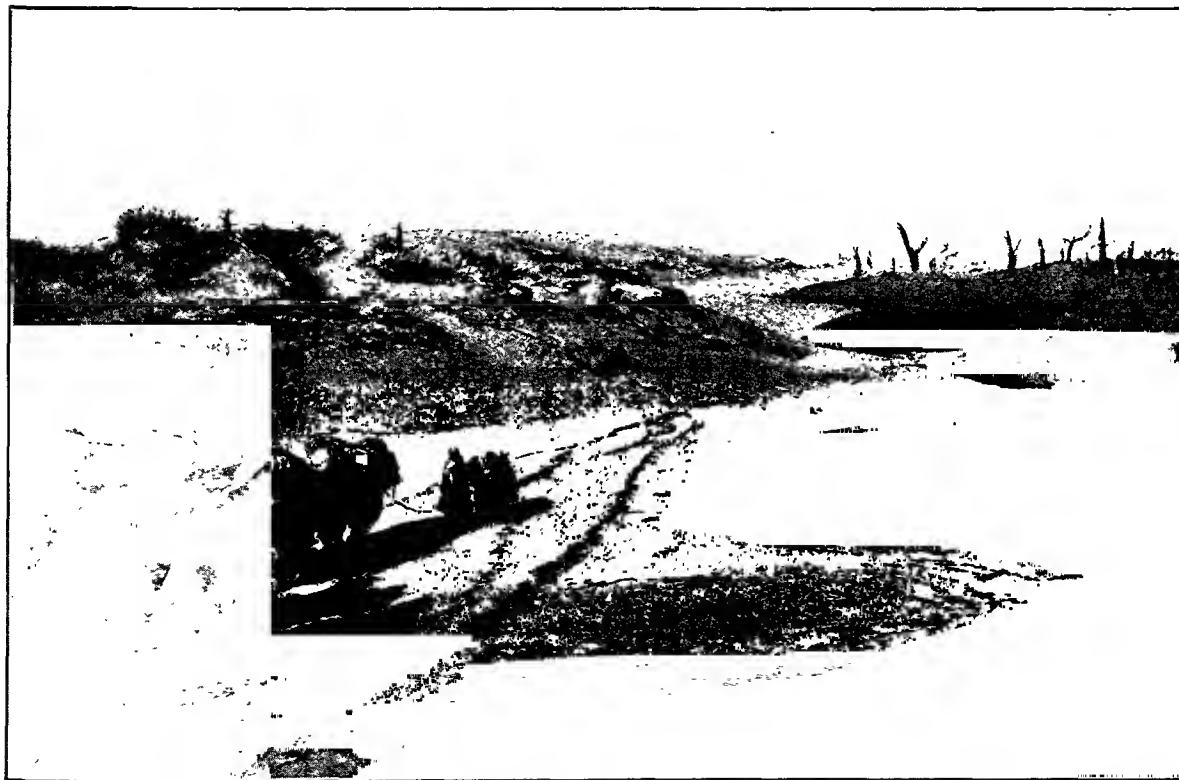


Fig. 335. AN OLD BED OF THE TSCHERTSCHEN-DARJA SITUATED TO THE NORTH OF THE PRESENT RIVER. VIEW LOOKING NE.



Fig. 336. THE OLD RIVER-BED TO THE NORTH OF THE TSCHERTSCHEN-DARJA.

some dead, some living. To the north sand predominates. The bottom of the river consists chiefly of sand, rising in some places into small dunes, and there are a few mounds actually in the middle of the bed itself. On the right bank we came across traces of a village, namely two square huts, built of faggots and branches and kamisch, projecting about one meter above the sand-smothered soil. The name given to huts of this description is *gerem*. There was also surviving the lower part of a wooden house. To judge from the hard and trodden appearance of the droppings of live stock in the vicinity, these huts had

been inhabited by shepherds, and could not very well be of any great age, any more than the Tschong-schipang bed could. For if the river were very old, it would have been already filled with sand-dunes. Immediately below this point the old river-bed divides. The right arm, which returns directly to the river, is called the Kalta-schipang; the other, the principal branch, continues towards the east-north-east. In this we discovered the remains of a double dam, constructed of beams, piles, faggots, and clay, which seemed to have been made for the purpose of forcing the river to the right. Upon reaching Mätschit (ruins of a mosque) we were again quite close to the Tschertschen-darja, the old bed being only separated from it by a strip of tamarisk-mounds and bush forest; but they soon diverge again for a space. The last portion of the old bed is indistinct, becoming lost amongst the sand and vegetation, but at Su-ösgen it once more reunites with

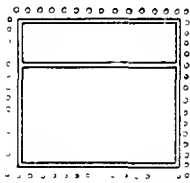


Fig. 337. PLAN OF A SQUARE HUT.



Fig. 338. FIELD OF THICK KAMISCH ON THE LEFT BANK OF THE TSCHERTSCHEN-DARJA.

the Tschertschen-darja. Beyond this point our guides had no knowledge of any other old watercourse on the left of the Tschertschen-darja. It was now snowing again quite briskly.

On 3rd February we followed for a short distance the road on the left bank, travelling amongst bush, poplars, and fields of thick kamisch. Here the new-fallen snow did not lie upon the ground, but formed a layer 1 to 3 dm. above the surface of the ground, being supported by the leaves and stalks, and as this hollow crust kept breaking under our horses' hoofs it made the ride very irksome.



Fig. 339. CROSSING THE SNOW-COVERED ICE-SHEET OF THE TSCHERTSCHEN-DARJA.

At length we reached Darja-kosch, a place on the right bank where a kona-darja branches off. The name denotes, properly speaking, the contrary, that is to say, a point of junction; but in these matters the natives are not very accurate. During the rest of the day's journey this old bed ran parallel to the existing river, proving that the latter does not everywhere turn to the right, but on the contrary, along this stretch at all events, travels towards the north. Two of the forest-tracts are known as Toghri-jangal and Jaslak. We now crossed the level snow-sheet which covered the frozen river. Both banks are clothed with thick kamisch, and backed by tamarisk-mounds, and sand-dunes which appear to be in a state of transition into mounds, for there cannot exist the least doubt that it is in this way these formations, which are so characteristic of the whole of East Turkestan, do also originate. A small tamarisk bush serves as the beginning of a small dune, and this increases as time goes on, and as it does so the bush continues to grow bigger in its endeavour to keep above the surface. This holds the dune fast, making it sta-

tionary; at all events that portion of it which is permeated by the roots of the tamarisk remains stationary, though the flanks or wings do pursue their course unchecked. In this way the mound comes eventually to be isolated or free-standing, or nearly so. This explanation of their origination and mode of formation is not alone sufficient, for tamarisk-mounds are also formed in districts where there exists no sand, nay



Fig. 340. A TOGHRAK MEASURING 6.80 M.  
AROUND ITS BASE.

actually in regions where it may be assumed that there never has been sand, as at Dunglik on the road from Abdal to the mountains. Here the explanation given in an earlier chapter holds good, coupled with the tendency which the bush itself shows to raise its mound, partly by holding together the material that accumulates about its roots, partly through the leaves and branches which it drops, and partly again as a consequence of its own growth upwards. (See also Pl. 56.)

Soon afterwards we passed on the right two old canals and a river-bed called Alim Achuning-ilegi. This last is not the same as the kona-darja just mentioned; nor is it so distinct as an old arm, owing

to its being smothered in thick reeds, and filled with tamarisk-mounds, dunes, and single poplars. Here and there there exist patches of barren saliferous soil (schor), formed by spring-water and converted in summer into marshes. At Mäpäschlik we were close to the river again. Over against Basch-jaman-kum on the left bank there are some living poplars, which so far as circumference is concerned are the biggest I have ever seen. Although not more than 6 to 7 m. high, two of them measured 4.75 m. and 6.80 m. respectively round the base; the actual trunk was however little more than one meter high, but was crowned by a gigantic »plume» of gnarled and fantastic branches. In these trees we have further evidence of the likelihood that the river has preserved its present position for a long time past.

Immediately beyond these poplars we found the ruins of old clay houses and walls. The general impression conveyed by the locality was, that it had been a



Fig. 341. TOGHRAK-FOREST.

former Muhamedan burial-place or *gumbes*. There was a square wall, 1 to 2 m. high, and 3 m. long, which closely resembled the basement of such a structure. Another looked like a monument or an arched gateway. A little distance away were the remains of some houses, the biggest of which had inside walls measuring



15.15 m. and 12.80 m. respectively and 0.68 m. in thickness. The material of which they were built is sun-dried clay, baked into bricks, precisely as similar bricks are made to-day in the same part of the country. Alongside the ruins runs an old arik, though it is only discernible at intervals. Besides these, we observed also patches of cultivated land, and a place where a threshing-floor had been; and there was, further, a ring of piled up, but rotten, straw. All this goes to show, that it cannot have been very long since the place was abandoned.

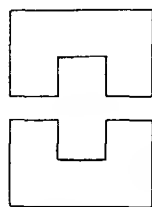


Fig. 342.

A »GUMBES».

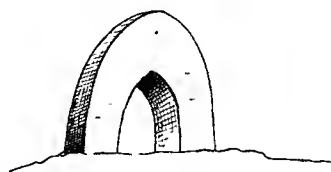


Fig. 343. ARCHED GATEWAY.



Fig. 344. VERTICAL SECTION OF AN OLD ARIK.

After that travelling was in many places very hard work owing to the strips of sand, mounds, tangled bushes, dead wind-fallen timber, and kamisch. The sand lies parallel to the river in long, narrow strips, and between them are similar long beds of perfectly level kamisch.

On the 4th February we came upon the curious graves, of comparatively recent date, which I have described in *Central Asia and Tibet*, and consequently I have no need to dwell upon them here. I merely append a sketch of one of the coffins; they were made of fresh, hard poplar wood, which was in a good state of preservation.

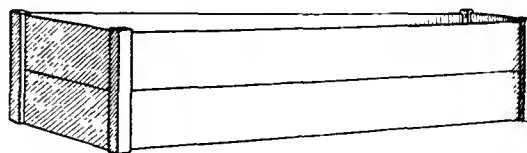


Fig. 345. A WOODEN COFFIN, FOUND ON THE RIGHT BANK OF THE TSCHERTSCHEN-DARJA.

Continuing north-east, we travelled across steppe-land alternating with toghrak forest. Here we perceived traces of an old arik, possibly a continuation of the one already mentioned. Here was a shepherd's hut known as Kijik-talning-baschi. The high sand to the south was now visible 8 to 10 km. distant, the intervening space consisting principally of barren *schor*. Tigers, wild-boar, red-deer, roe-deer, and hares were plentiful. After crossing a depression, which is said to contain water at the season of high flood, we travelled for the rest of the day along the ice of the Tschertschen-darja, and an excellent road it proved, being hard and level, and we no longer had to contend with the tangled thickets which made travelling along the banks so slow and exasperating. Off those parts that were exposed to the prevailing north-east wind the snow was swept away, but in other places it lay to the depth of about 1 dm. Generally speaking, the conformation of the river-bed bears a very close resemblance to that of the Tarim, though its detailed features were masked and confused by the ice. For instance, it was very rarely we saw any alluvium or mud islands, because they were underneath the ice. All along, close in to the banks, there grow reeds, while as a rule tamarisk-mounds, in many cases half washed away by the river, crown the sharp-cut scarped banks. In places pieces



Fig. 346. TAMARISK-MOUNDS HALF  
WASHED AWAY.

of driftwood stuck up through the ice, as well as small insular patches of kamisch. The breadth was tolerably uniform, and the river not especially winding. On the left we passed the *lenger* of Sarik-uja. Beyond it the country is called Ghatschilik and Käläkujdi.

On the 5th February we continued along the right bank, where the vegetation was unmistakably more plentiful than on the left bank, for there it was greatly encroached upon by the sand from the north. Except where they were masked by forest, the absolutely barren dunes were always visible, being sometimes of considerable size. Beyond a doubt these play an essential part in determining the position which the river has assumed. Not that the barren sand by itself exercises any direct influence upon its course, for it is readily swept away by the current, but all along its outskirts it becomes gradually bound together by the tamarisks and poplars, and once it gets sufficiently consolidated through the retentive power of the roots, it then serves as a new point of departure for fresh encroachments and fresh invasions — that is up to a certain point; for these obstacles are not sufficient to force the river to go on assuming step by step a more southerly course. The two successive seasons of high water which follow one another with accentuated force sweep away all hindrances, and keep the channel open. The wide stretch of level country which extends between the right bank and the zone of sand in the south is kept moist, partly by annual inundations, partly by brooks from the mountains. At the same time this difference between the character of the two banks does render easier the flitting of the river towards the right. During the day's march the poplar woods were more abundant on the right bank than on the left, for on the latter they were encroached upon at intervals by the dunes. In general it may be stated, that the river possesses a fairly broad valley or channel, and the old watercourses which exist on both sides of it give the impression of being divisions of the actual river-bed. That the river is old is also evinced by the poplars, which are ancient and of great size. The distance between the two belts of sand is, I dare say, 10 km.; but of the southern belt all that was seen was as a rule the outermost dunes clothed with vegetation. Here too there was a narrow strip of open running water, though very often it disappeared under the ice; evidently then the Tschertschen-darja was not frozen to the bottom. Over against Dimen-tokaj there is on the right bank a tolerably good bridle-path; and here we crossed over a dry watercourse, through which in summer flows a little brackish water out of the schor marsh. At Ak-tas-dung, where on the right bank there is a *nischau*, or «signpost», crowning the top of a hill, there exist indications that the river overflows its channels. Below that spot there is another abandoned watercourse, which is said to have been dry for as long as anybody can remember; it is only 10 to 20 m. broad, and its banks are planted with poplar woods. This arm rejoins the river at Kallaste. After that the Tschertschen-darja, and with it the road, turns to the north-east and north-north-east, and for long distances the ground is *schor*, moist and free from snow. We even passed two or three unfrozen marshes. The name of the district is Usun-schor. At Kumtschakma, on the left bank, the sand is high and barren, and approaches quite close

to the river. But on the right it recedes a long way from it; in fact, it was only distinguishable through the narrow edging of snow which lay on its outside dunes. We encamped at Basch-otak quite close to the river.

On the 6th February the stinging cold still continued ( $-29^{\circ}$  C. minimum), but it had ceased snowing, and there was less snow lying on the ground than in the Andere quarter; the greater part of what fell had evaporated. We again crossed to the left bank at Ak-ilek, where an old left-hand bed begins. This runs parallel and quite close to the existing stream, winding but little, and has at first living poplars on its banks, then dead forest, underwoods and steppe, in fact on the whole a rather rich vegetation. In places there are rudimentary dunes in the river-bed; the great desert being only about one kilometer distant on the north. At Bachtemet the arm divides in the same way as the river-bed of Tschong-schipang; the right branch re-entering the Tschertschen-darja at Bachtemet-lenger, while the left branch, the larger of the two, continues past Boghuluk and Läschkär-satma. At Dung-aghil we again crossed the river on the ice. Here it was narrower than it had hitherto been, and was shut in between tolerably well-scarped erosion-terraces, 3 to 4 m. high. At this point it is crossed by the Tscharklik road, whence the place is also called Kätshik (the Ford).



Fig. 347. KAMISCH AND TOGHRACS ON THE LEFT BANK OF THE LOWER TSCHERTSCHEN-DARJA.

From what we ascertained by reconnaissance, this old river-bed comes to an end at Boghuluk, disappearing amongst the outlying dunes, which however approach quite close to the Tschertschen-darja. We supposed that, as we proceeded, we should somewhere light upon the termination of this old bed, but we never did. Still it does no doubt rejoin the mother-river, but the junction is masked by vegetation and sand. In several places indeed it would have been impossible to see any such

river-ending, even if there had been one, because of the drift-sand which advances right down to the Tschertschen-darja. It is equally possible, that this old bed is continued farther north, through the desert itself, and so it may not rejoin the mother-stream before reaching the Ettek-tarim. This is even more likely when we call to mind that the Kara-buran and Kara-koschun are recent creations, and that in the time of the old Lop-nor the Tschertschen-darja probably discharged into it, unless indeed it possessed its own discharge lake situated where the Kara-buran or Kara-koschun now are. This problem, of no great intrinsic importance in itself, could be solved by crossing the desert from Basch-arghan to the lower Keng-lajka.

Continuing our journey along the left bank on 8th February, we found no trace of either path or human beings. The country was desperately monotonous, no fresh feature appeared, — silence and desolation shrouded in snow, though this was now thinner — no game, not even so much as a raven, to be seen! And what was worse, we had not succeeded in finding a guide for this part of our journey;

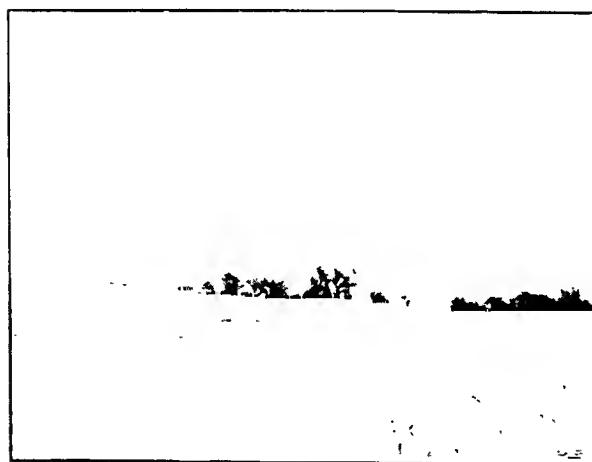


Fig. 348. POINT WHERE THE NORTHERN SAND COMES INTO CONTACT WITH THE VEGETATION OF THE TSCHERTSCHEN-DARJA.

consequently I failed to learn the names of the localities. With the view of avoiding the reeds, which were frequently of incredible density, we travelled a little distance from the river, keeping along the edge of the desert. Indeed we sometimes crossed its outlying dunes, and only touched the river at two or three of its windings. The sand in the immediate vicinity of the stream was for the most part planted with tamarisks, but their boundary-line was very sharply drawn, for they seldom extended as far to the north as we were able to see. The high barren sand ran about one kilometer or a little more back from the

river. The ground was everywhere »sanded», and when the kamisch steppe came to an end, its place was taken by other kinds of scrub (tschige, jantak, köuruk, etc.), which grow upon quite miniature cones, making the surface uncomfortably lumpy. The river valley appeared to be here broader than it had been before and the river with its interminable canopy of ice frequently swelled out into small lake-like expansions. It wound about a good deal, though nothing like to the same extent as the lowest part of the Tarim. The edge of the southern sand-belt still continued visible the whole time. The poplar forest was very thin and the trees young, with the exception of merely a couple of clumps of old and gnarled veterans that we passed. Generally there was a tiny rivulet of open water hugging the left bank. In one sharp angle the ice-coverlet was completely under water; probably the open rivulet had somewhere or other become entirely frozen up. The river and the northern sand came into close contact with one another at one bend only; but there the almost completely barren dunes, some 10 m. high, shot down abruptly into the river, and the river was undermining their

base, exactly as the Tarim does where its angles touch the desert. Viewed in outline, the river-bed winds in a tolerably regular manner, serpentine backwards and forwards between the sharp-cut erosion-terraces; and the level ground below is covered with dense beds of reeds. Fig. 350 gives a vertical section of it. The dunes turn their steep faces persistently towards the south-west, with slight deviations to the west-south-west and south-south-west. The narrow strip of vegetation which is induced to spring out of the soil through the magic of the Tschertschen-darja is in imminent danger of being overwhelmed by the dunes; but so long as the river maintains its existing volume, the efforts of the sand are doomed to failure.



Fig. 349. ORDINARY TOPOGRAPHY OF THE LOWER TSCHERTSCHEN-DARJA.

On 9th February the country still continued the same, except for a few small details. Indeed, what else could one expect on the verge of the desert and on the banks of a desert river? The ground was excellent for travelling, and we covered fully 30 km. Our line of march was prescribed by the edge of the sand-dunes, and these terminated quite abruptly; it was very seldom indeed that any small dune detached itself from the otherwise continuous wall of yellow sand. Along its base we again had the thin scrubby steppe, interrupted at frequent intervals by absolutely level patches of schor, caked over with saline incrustations and with mud deposited by the river. The breadth of the steppe zone increased as the river moved downwards. Poplars were few and far between, but still they did occur, and towards the end of the day's march they were of a mature age. The breadth of the reed-belt along the banks varied, though sometimes it contracted to a mere narrow ribbon. While the dunes of the southern sandy zone decreased in altitude, those of the great desert on the north appeared to grow bigger, and to attain 30 m. in height. The snow had again decreased in quantity, the ground being for the most part free from it, though there were little patches surviving in the shelter of the scrub and treemounds. On the frozen coverlet of the river too it had almost all gone, so that the ice glittered like polished metal flashed in the sunlight.



Fig. 350. VERTICAL SECTION OF THE SAME.



Fig. 351. GIVING THE HORSES A DRINK.

On 10th February there was a fresh north-east wind. The surface was sandy, and at intervals there were mounds bearing dead or living tamarisks. The patches of schor that we crossed were surrounded by them and by low sand, giving them some resemblance to bajirs. The high sand is here about 3 km. distant from the existing river-bed; indeed it is surprising it has not yet quite reached it. It seems to fight shy of the belt of lean and scanty steppe, for it terminates quite abruptly, forming a continuous wall, the silhouette of which showed that the dunes turn their

steep leeward face consistently towards the south-west. It is however true that, the prevailing wind blowing from the north-east, these dunes ought to advance parallel to the Tschertschen-darja, and consequently can hardly be expected to approach it to any appreciable extent. On the other hand the north-north-east wind, which not seldom blows, might be expected to force at any rate the smaller outliers down against the bank. But it may be mentioned, that there is here an old river-bed which may in its time have served as a »breakwater» against the sandy desert, and possibly this has some bearing upon the circumstances. This river-bed, beside which we

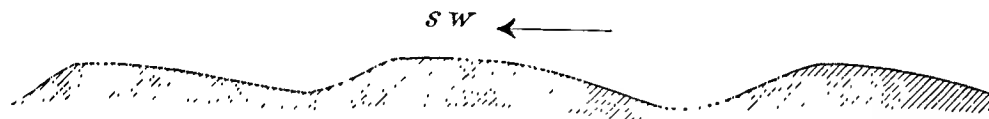


Fig. 351. HIGH SAND ON THE NORTH SIDE OF THE LOWER TSCHERTSCHEN-DARJA, GOING SW.

journeyed for some distance, makes an exceedingly sharply accentuated depression. It leaves the river immediately below our last camping-ground, and gradually diverges from it. At first its bottom is level and free from sand, but soft, and in places whitened by thin incrustations of salt. Eventually the sand begins to show itself in it, but after that it is filled with fine, loose dust, so exceedingly soft and treacherous that two or three of our camels, which were going down amongst it, fell and had to be freed from their burdens, and after immense exertion hauled up again. Measuring the river, we found its breadth to be 32 m. and its depth from the level of

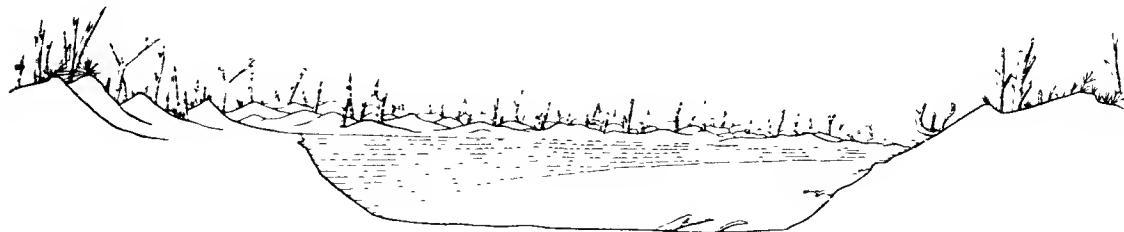


Fig. 352. PANORAMIC SECTION OF THE OLD RIVER-BED.

the scarped bank  $6\frac{1}{2}$  m.; in this latter datum there was little change. Indeed the uniformity in this respect is so great that you often fancy it is a specially dug canal intended for boats of deep draught. Seeing now that this river-bed is not more than one-fifth or one-fourth the breadth of the adjacent parts of the Tschertschen-darja, and that it is also more sinuous, and of a more uniform depth throughout, the suggestion naturally occurs, that it is merely that part of the old river in which the actual current flowed, and that all its accompanying low alluvia and convex angles have become choked with sand and rubbish and vegetation, and in consequence of this have become gradually merged with the adjacent country. Before leaving this bed to return to the Tschertschen-darja, I had a look round from the top of a high tamarisk-mound, and perceived that the old bed continued a good distance farther towards the north-east, winding along the foot of the high sand. It was especially easy to follow because of the large quantity of dead forest on its banks, distinctly marking them out. Here then there was once a poplar forest, and its grey, withered tree-trunks are still standing *in situ*. There is also a large quantity of drift-wood, half buried in the fine dust at the bottom of the river-bed. From this bifurcation onwards the poplar woods beside the Tschertschen-darja grow rarer and rarer. We only observed one small clump near the bank, but the trees were not more than 30 to 40 years old; there is a far more abundant forest beside the old river-bed. We did not succeed in discovering any continuation of this last, and as there is no breach in the dune-wall through which it could have found a passage, we must infer that its lower part is entirely buried under drift-sand, and that it does not rejoin the existing Tschertschen-darja anywhere, but that it used formerly to enter the lower Tarim or the Ettek-tarim. The older branches which we discovered on the left of the river indicate that the lower Tschertschen-darja really has moved towards the right, that is towards the south, the advancing sandy desert having forced it to recede step by step in that direction. Its arms too put one in mind of an inland delta like that of the Tarim.

The space between the river and the old watercourse we have been considering is occupied by steppe of the usual character, but it grows more withered and moribund the nearer it lies to the latter. On the way back to the river-bank we had to cross a kamisch steppe, where the reeds grew so extraordinarily close together that we very nearly got stuck fast in them. The ground underfoot was in fact a marsh, though it was then frozen. It was now a great rarity to come upon a patch of snow remaining on the ground. At length however we hit upon a little foot-path and traces of shepherds; and on the bank we found a satma, Takta-pere (pron. »peji»), beside an open freshwater lagoon, formed probably by overflowing ice-water. The low dunes, bearing vegetation, of the southern belt of sand advance here to the edge of the river.

On the 11th February we travelled for the most part in the bed of the river, which was still broad, with thick reeds next the bank. The limits of the river-valley and the range of its banks are indicated by hills of sand or dust, clothed with vegetation, and dotted with tamarisk-mounds. Poplars are still seen, though widely scattered; several of them appear to have reached a pretty good age, though most of them are young; indeed just here the forest seems to be spreading and gaining

ground. About midway in the day's journey the river contracted for a short distance to a width of not more than 30 m., so that it resembled a canal, with dense beds of reeds on both banks and tamarisk-mounds standing often on the actual water-line, especially towards the right bank. Here the ice-sheet was thick and firm, though it had many holes in it, which the shepherds had hewn to get water for their flocks. In other parts however the river-bed was only half frozen across, and

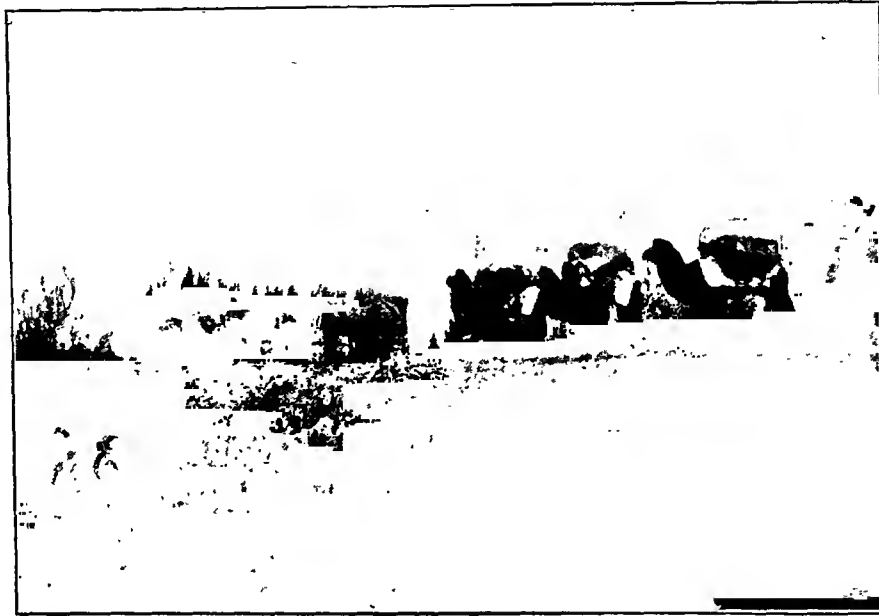


Fig. 353. THE SATMA OF ARALTSCHI.

the ice, which was very thin and broken at the edges, rested immediately upon the mud and clay of the bottom. The river flowed here very straight towards the north-east, so that we only had to cross low tongues of land once or twice. In the district of Negetschagh-asghan we passed two huts, and in a third, in the district of Araltschi, came at last upon a shepherd family, in charge of 600 sheep, 6 cows, and two or three horses and asses. The shepherds said, that, if we were to go due



Fig. 354. ARALTSCHI.

north from Araltschi, in the direction of the great drift-sand which we saw a few kilometers away, we should cross a tract with dead forest, but there was no trace of any old river-bed, though possibly there might be such amongst the sand, forming a continuation of the watercourse we had seen on the preceding day. At Araltschi the river turns to the east, and grows as broad as a lake, being divided into four arms by three reed-grown islands. The banks are generally at the same level as the bottom of the river, or even lower, so that the ice extends into the reed-beds



on both sides. On the right bank there is a little lake, formed by a side-arm of the river, and fed at the season of high flood, a circumstance that recalls the lower Jarkent-darja. Except for this the river is in many respects like the vacillating and undecided Chotan-darja. If through any change the masses of water were to abandon this bed, it would soon disappear entirely, leaving no perceptible channel behind it; and in any circumstance it would be hidden in the dense reeds. From this point downwards the river and its adjacent banks are known as Keng-lajka, or the Broad Mud Region, a very significant name, which might very well be translated by the simple word »Delta». The vast quantities of sediment which the river brings down with it in the season of high water are deposited here, and as time goes on form a flat triangular accumulation of mud, through which the river-arms often change their course and situation. Opposite to the three islands I have mentioned the river



Fig. 355. VERTICAL SECTION OF A NARROW PART OF THE TSCHERTSCHEN-DARJA NEAR KUM-KUJULMA.

is touched by a minor outlier of the sandy desert on the north, the place being consequently known as Kum-kujulma or the Eaten (*i. e.*, Eroded) Sand. The southern sandy desert is at this point a long way off, and has in front of it a zone of tamarisk-mounds, the northern edge of which is as sharply demarcated as a wall. Still the southern desert *is* visible, although its dunes are considerably lower than the northern. Strange to say, the toghrak forest still attains in places a quite respectable development, as for instance at Jigdelik-aghil, where there were shepherd families dwelling. Altogether there were ten families in that neighbourhood, and they had charge of about 1,000 sheep belonging to the bajs of Tscharklik. There is no cultivable ground there. Nor were there any longer traces of snow. Although it had indeed snowed more that winter than for a good many years past, the amount that fell here seemed to be appreciably less than in the neighbourhood of Andere.

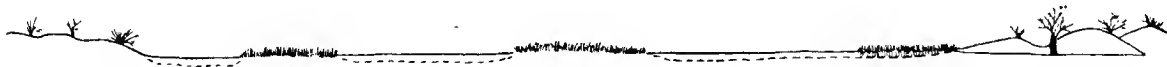


Fig. 356. VERTICAL SECTION OF A BROAD PORTION OF THE RIVER AT KUM-KUJULMA.

In this connection I will add certain information which was given me by these shepherds. The mus-suji or spring-flood was expected about the middle of March. It is said to attain formidable dimensions, and to last for ten days. After it has passed, there remains but a narrow belt of water, until the summer flood comes down from the mountains. This too swells to imposing dimensions, lasting about eight days, after which the stream gradually subsides. When it is at its maximum it is impossible to ford the river, not so much because of the great volume of the water, for it is spread over a wide area, as because of the disturbed and softened

mud, into which both horses and wayfarers on foot sink deeply. Going back, upstream from Jigdelik-aghil to Boghuluk, the stretch that we traversed without guides, the shepherds supplied me with the following names, which for the sake of completeness I will here write down — Kum-küjülma, Karaul-dung, Araltschi, Negetschagh-asghan, Takta-pere, Buka-tschapghan (left bank), Schor-sulak (left bank), Kum-tschakma (right bank), Jussup-baj-satmasi (left bank), Schaptul-köli (right bank), and Toghrak-aghil. The lake of Schah Toktaning-köl, which is shown on Roborovskij's map, is situated south of Jigdelik-aghil. The oldest man amongst the shepherds, Molla Chodscha, who was also the chief of the community, told me, that his grandfather Tinakul Bek, used to live at Karaul-dung, but he had never heard that any part of the desert had been called after him. Roborovskij however calls the desert north of Keng-lajka by the name of Tinakul-bekning-kum.

Between Jigdelik-aghil and Tscharklik there is a route, 55 km. long, which can be traversed by camels in two days and by a man on horseback in one day. This, after passing Tüschkün, proceeds along the dry bed of the Sollak-darja. Halfway the road is crossed by the stream which, starting at Tatlik-bulak (between Jakub Baj-kuduk and Vasch-schahri), flows north-east; at the intersection it is known as the Atschik-tarim. Thus the Tatlik-bulak, or Fresh Spring, on reaching these lower levels, becomes known as a Salt River (Atschik-tarim), an indication that its water is contaminated by the saliferous soil it passes through. After rain in the mountainous districts, this stream sometimes joins with the Tscharklikning-su above Nadschi-bidschin, and from that point the united river proceeds towards the Kara-buran, though it seldom reaches it. It is only the northern half of the road I have just mentioned that crosses a belt of dunes; the southern half traverses barren *schor*. Tamarisks grow at Atschik-tarim only. The Atschik-tarim river is joined by several other streams from the mountains, e. g. the brook of Vasch-schahri. Occasionally the volume is so great (*siz-su*) that for a time it renders the road quite impassable. Other natives assured me, that neither the Atschik-tarim nor the Tscharklik-su ever gets now as far as the Kara-buran, but that both generally disappear in the ground before reaching it, or after a very heavy rainfall form marshes, or spread themselves out, inundating the country south of the Kara-buran; but none of the ephemeral lakes thus formed ever sends a connecting branch down to the Kara-buran. This seems to indicate that the bottom of the last named lake has in the course of time become so raised by the mud of the Tarim, that it actually lies at a higher level than the tract of country to the south of it. The zone of dunes south of the Tschertschen-darja thins out in the district of Nadschi-bidschin, and comes to an end. At Tüschkün a branch, one year old, goes off from the main river, and after describing a deep curve to the north, proceeds to Lop. From the beginning of the Keng-lajka the high water no longer flows in a definitive channel, but spreads out in deltaic fashion, the river breaking up into a number of radiating arms, a procedure which the natives further facilitate by digging canals with the object of watering as wide an area of their pasture-grounds as possible. At the present time there is no flowing water derived from the Tschertschen-darja. At Jigdelik-aghil it is always possible to ford the river. In contradistinction to the Tarim, in which the irregular supplies derived from several different feeders, situated a great distance away, gradually find their proper levels, there is in the Tschertschen-

darja, as far down as Keng-lajka, an unperiodic oscillation of level, caused by alternate rain and drought in the mountains. Old Molla Chodscha was unable to give me any information about an old bed of the Tschertschen-darja, though on this side of the great barren sand there is, he knew, near its base, a strip of dead forest, which possibly may mark an older position of the river.

For my journey up the bed of the Ettek-tarim I was fortunate to obtain an excellent guide in old Toktasin Bek, who knew the road intimately, and who told me that in 1879, when he accompanied the fugitive Nias Hakim Bek along that route to Korla, the bed still contained pools of water, which, although salt, were still drinkable at a pinch. He assured me, that the bed was abandoned thirty years ago, but that previous to that it had carried about half the volume of the Tarim. The Ettek-tarim discharged a little west of the village of Lop, in the locality still called Basch-aghis, or the Principal Mouth, clearly in contradistinction to an Ajagh-aghis, or Lower Mouth, farther to the east, where the existing arm of the Tarim, then newly formed, discharged its waters. According to Toktasin Bek the Ettek-tarim was not, even thirty years ago, joined by any old arm from the Tschertschen-darja. Whence it is clear that the Tschertschen-darja has occupied its existing bed since the time when the water of the Tarim ceased to pour down the Ettek-tarim. Nevertheless I do not consider the eventual discovery of an old bed of the Tschertschen-darja to the north of the existing channel as altogether unlikely. We had ourselves seen two arms break away from it and get lost in the sand. The natives indeed assert that there exists no such bed between the existing river and the edge of the high sand, though they do admit that there is a strip of dead forest along the margin of the desert. Hence it is very likely that a bed, which penetrates into the sand, may eventually in its lowest parts disappear entirely under the dunes, and these in a period of thirty years may have had a sufficient length of time in which to bury it, leaving only the last remnant of its dead forest to project above the sand. In the actual delta of the Tschertschen-darja one may perceive dunes beginning to form. But the material for them does not come from the Desert of Lop; the distance is too great and the sand cannot get across the marsh. Consequently it is with deposited river-sand that they build themselves up, and the sand is derived from the deltaic arms which have dried up after being deserted by the water. It is true, as the natives of Keng-lajka indeed point out, that every year the Kara-buran decreases in area, and probably will eventually disappear altogether; but even on the east side of the Tarim the sand of the Desert of Lop does not get all the way to the river, as I shall subsequently describe. The name Kara-buran is unknown in the locality with which I am now dealing, and the lakes in question are called by the natives Lop-köli.

On 13th February we followed at first the right bank, then crossed the river, and so came to the *ajrilghan-je* or »place of bifurcation». Below this point the country is called Tüschkün, because it is here that the Tscharklik road »goes down» to the river-bank. The dry branch of the river on the right continues to be accompanied by clumps of toghrak; the left branch, which we followed all day, was formed in 1898, and is excessively shallow; it is only in a few places that it has cut erosion terraces, and then on an extremely modest scale. Along the bottom of the

channel wound backwards and forwards the ribbon of ice, sometimes very thick and with a current running underneath it, sometimes already thin and soft in the mid-day sun. Every now and again the new river divides, but the arms soon reunite. There is not a single poplar to be seen, either young or old; but the reeds are thick and vigorous. Farther back from the banks there is steppe, but its scrubby growths are dried up and withered. For long distances we quitted the left bank, and made our way through a belt of newly formed dunes 3 to 5 m. high. These all turn their steep faces towards the south-west, and are often clothed with vegetation; otherwise the detached free-standing individual dunes exhibit regular and characteristic forms. A little bit farther away from the river they are massed together, and fuse into chains of greater or less regularity, the beginnings of dune-accumulations. The high barren sand continues to rise into dome-like masses some kilometers distant, though during the course of the day it decreased, at the same time that the accumulations appeared gradually to diminish, though this may have been merely an optical illusion. Sometimes we would cross a hollow left by some old water-course, and frequently we traversed lumpy *schor*; which again points to inundations having occurred in this changeable deltaic land. The dark green *köürük* plants grow crowded together in some places, and make as it were dark islands in the otherwise monotonously grey landscape. Close beside the river are some marshes formed by the last overflow of the high water, but then frozen to the bottom. So far as we were able to see, the country was perfectly level. The new river-bed still continued to move away from the dry arm on the right, and also from the Sollak-darja; and the belts of vegetation beside these last soon disappeared from view.

The place where we encamped is called Koschmet-köli. Toktasin Bek remembers perfectly well that during his youth, 50 years ago, there was here a lake bearing the same name, or rather it was a complex of small lakes, and they were fed by an arm that left the Tschertschen-darja at a spot below Tüschkün, and proceeded as far as the lakes at Basch-aghil. The locality derives its name from a well-known man Koschmet. Probably the same name occurs again in Koschmet-kum, or Koschmet's Desert, that we find in Roborovskij, though by this can only be meant the barren sand-dunes which lie immediately north of the Koschmet-köl. The lakes again discharged into the Lop-köli. The people who lived in this quarter supported themselves almost entirely upon fish. About forty or fifty years ago, however, these lakes dried up, no doubt in consequence of some fresh change in the delta of the Tarim. The village of Lop is said to be at present inhabited by six families, who do not keep sheep owing to the poor pasturage in those parts, but live upon fish. Wild camel are no longer found in the adjacent deserts, but from time to time tigers are seen near the river. The people thought the ice would not last much longer than twenty days, for when the first freshets come from the melting ice above, it is unable to offer any further resistance, but breaks up in the course of a few days. Strange to say, the water which was then flowing along certain open channels was so salt that we could not drink it. This is to be ascribed to the *schor* or saline character of the soil as a whole, coupled with the fact that the river is so new. When it grows older, and the river-mud from the higher Tschertschen-darja has deposited itself along the bottom, the saline impregnation will disappear. At Koschmet-köli there was a scarcity of

fuel; we were unable to find anything better than the roots of dry tamarisks, together with two or three old poplar trunks, which showed at any rate that, barren as the country now is, this tree was formerly able to thrive there.

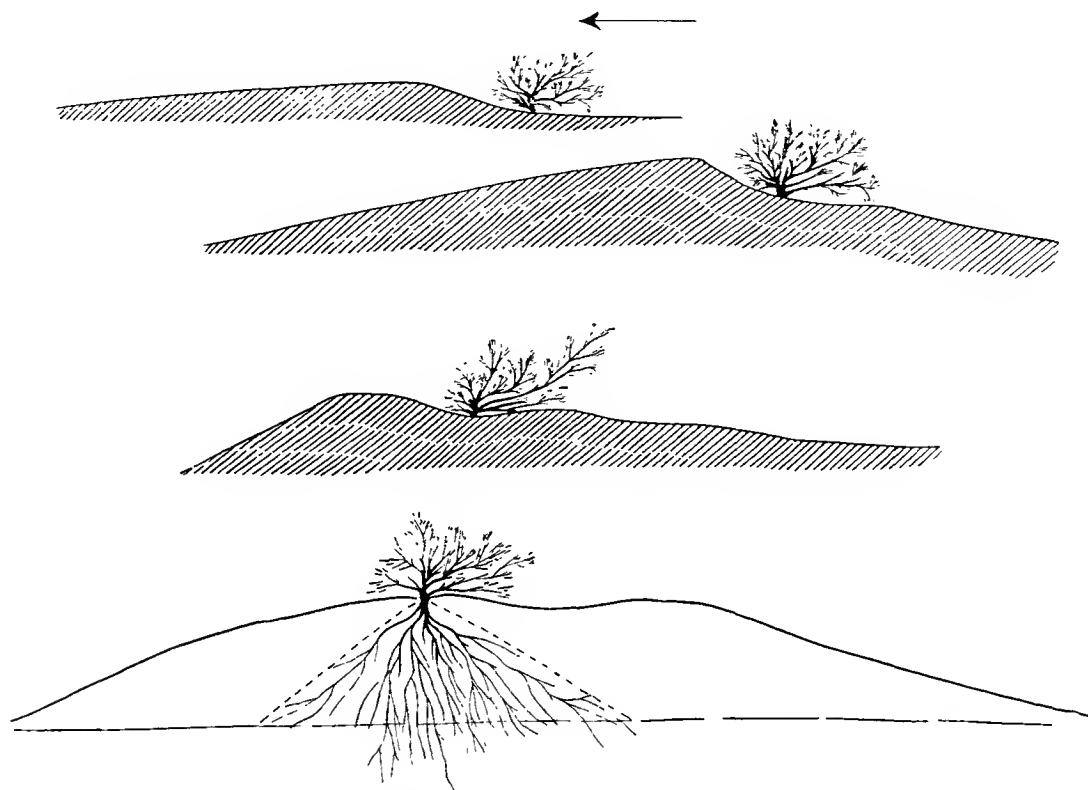


Fig. 357. SHOWING ONE OF THE WAYS IN WHICH THE TAMARISK-MOUNDS ARE FORMED BY HELP OF A SAND-DUNE, WHICH IS LATER ON, BY SOME REASON OR OTHER, BLOWN AWAY OR SWEEPED AWAY BY WATER.

On 14th February we made a short march of 15 km., for we had to stop at Basch-aghis, the last place at which we should find water before we reached the Tarim, so that we had to provide ourselves there with a supply of ice. There is a distinct path leading thither, a short distance from the left bank, though the river itself is generally hidden by the thick reeds. We had no difficulty in identifying the site of the lake of Koschmet-köl, in the long string of grey, roughened surfaces, at once level and barren, which still wear the appearance of having been under water. The dunes grow distinctly lower towards the north-east. The border line between the sandy desert and the steppe is very sharply drawn; the latter has not yet succeeded in spreading itself over the former lake-basin, but stops abruptly on its margin. No sand is visible towards the south. The steppe vegetation consists of kamisch, scrub, and tamarisks, now abundant, now sparse. The young tamarisks have already begun to build up their conical bases, by arresting the sand, which will gradually be detained and held fast by their roots. The latter part of the journey led through new lakes and marshes, which had formed the year before in the basin of the old lakes, after the northern river-arm had brought a fresh accession of water. These new lakes consisted often of pretty large expanses of ice, surrounded by reeds and mounds, and on the north by sand; in general they penetrate the yellow reeds in

all directions like fingers. Except for a thin sprinkling which still remained on the sheets of ice, there was no snow to be seen. These lakes come to an end at Basch-aghis, and from that point the Tschertschen-darja turns south-east and empties itself into Lop-köli, and after having passed the village of Lop, proceeds by a narrow arm to the point where (p. 221) we found its delta mouths. At Lop it picks up the branch or canal which we saw leave the Tarim just below Tschegelik-uj. At Basch-aghis, which marks the northernmost extension of the Tschertschen-darja, we were to turn our backs upon the river in order to cross a desolate and waterless region. Here there were still standing some huts, inhabited about 40 years ago, when this branch last carried water, and the lakes were still full. Another interpretation of the name would be the »head, or principal, or upper mouth», indicating that the Tschertschen-darja here flowed through a larger lake; but the explanation I have already given, taken in conjunction with the Ettek-tarim, is more likely.

The day had been more spring-like: at 1 p.m. the thermometer registered + 0°.4 C., although during the previous night it had been down to — 24°.0 C.

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## CHAPTER XXV.

### THE ETTEK-TARIM — TAGH-KUM.

I looked forward with great interest to the journey north along the old abandoned bed of the Ettek-tarim, which we began on 15th February, because I hoped that the observations I should make in the course of it would throw light not only upon the hydrographical problem in general, but also upon the Lop-nor problem, as well as upon the question of the situation and extent of the sandy desert. It is true, I had heard spoken, as also had General Pjevtssoff, of the existence of the old bed of the Tarim; but it had never been visited by a European, so that, from the purely geographical point of view, it was important to make a map of it.

Starting from Basch-aghis therefore, we first directed our steps towards the north-east, having the high sand about 5 km. distant on the left hand; its altitude I estimated at about 30 m. For some distance we kept along an old distinctly marked river-bed, which must at some period or other have served as an outlet for the Ettek-tarim, or perhaps it had been a branch of that river. It was bordered by dry, barren clay escarpments and ridges. South of the river the soil was absolutely barren, though at first there were dwarf tamarisks on mounds about one meter high, built up almost entirely of sand. In places there were fields of dead kamisch stalks, which looked as if they had been cut with a scythe or grazed off. They indicated the sites of former marshes and marginal lakes. Where the old bed is distinct, young toghraks appear, though thinly, as well as an occasional patch of

scrub (*jantak*) growing amongst the dunes; these, one to two meters high, look as if they were perfectly new creations, and evidently they have established themselves here since the water deserted the river and its lakes. The poplars were still vigorous, and did not appear to be more than 15 or 20 years old. My guide, Toktasin Bek, discriminated between the Ettek-tarim and the old bed I have just mentioned, calling the latter, characteristically enough, the Western Jarkent-darja. It is said to have formerly joined the Tschertschen-darja some kilometers south of the point where we crossed it, that is to say a short day's journey north-west of the village of Lop. Just beyond the district of Pajek-tschapghan, where there is a poplar grove, we crossed a path coming from the village of Lop, and saw on it the fresh tracks of asses with their drivers. The inhabitants of Lop, as well as the people of Tscharklik, are reported to visit the bed of the Ettek-tarim in winter to gather *jigde* berries; and all the way beyond Pajek-tschapghan the *jigde* bushes are very plentiful. This last name is also pronounced Pijek, and is said to be derived from a man who 50 to 70 years ago dug here a canal from the river. Immediately above that point the river divides into two branches, the western of which is also called Pajek-tschapghan. After that young poplars and tamarisks are quite numerous amongst the two-meter high dunes, the former frequently forming fairly dense »young» forest. Strange to say, *kötäk*, or »dead forest», is very rare, and during the course of the day was never more frequent than beside any other river-bank below which water is found.



Fig. 358. VIEW FROM THE SOUTHERN PART OF THE ETTEK-TARIM.

The place in which we struck the Ettek-tarim proper was the Julghunlik-köl, or the Tamarisk Lake, though at the present time there are no tamarisks beside it; after that we followed the river-bed closely for the rest of the day. Of the former lake however we found nothing remaining except the name; but my guide was able to tell me, that there used to be a marginal lake here, perhaps a »boldschemal» of the same kind as those which are so common beside the existing Tarim.

The well of Julghunluk-köl-kuduk was choked up with dust and drift-sand, but nevertheless is, it was evident, a well-known and frequently visited camping-ground, for by the side of it there was actually a wooden trough for animals to drink out of. The well itself is sunk in the deepest part of the bed, in a spot where formerly an eddy in the stream scooped out the bottom to a depth of 4 or 5 m. below the edge of the scarped bank. But even at that depth the bed was perfectly dry.

Beyond that point the young forest grows conspicuously thick, and then for a time we left the river-bed on our right to avoid a tiresome bend which it makes to the east. Once again we encountered patches of level mud, either barren or producing a scanty vegetation, marking the sites of former marginal lakes. At intervals there are small dunes, seldom more than 4 m. high. We frequently observed marks of old shore-lines. Tamarisk-mounds are common. At the point where we again struck the river, there is a path coming from the south-east, from Tschigelik-uj and Tokum; this again showed recent traces of travellers' presence. I was told that the path in question leads through a desert with *tschaval-kum*, or »scattered dunes«. Here the forest is fresh and vigorous, the trees being of medium age, and frequently it is dense and even magnificent. This points to the presence of groundwater near the surface, so that dig were we might, we should be able to get fresh water. We were now over against Schirge-tschapghan on the Tarim, according to the bek's calculation a short day's journey from it.

After that young forest alternates with mature forest; in places it is as vigorous as any forest there is beside the middle Tarim, and yet it is asserted, that it is 25 to 30 years since water flowed along that bed. For two or three years indeed pools had survived in the deeper parts, but these too disappeared many years ago. The well in the district of Kutschmet had fallen in. The fact of the old names remaining proves that that road is still frequently used; otherwise it would be forgotten, like the names beside the Kuruk-darja in the Desert of Lop, where nobody was able to give me a single name, although there were once as many names there as beside any other river of East Turkestan. When the natives definitely cease to visit the Ettek-tarim, then its names too will in like manner disappear. Its bed is extraordinarily easy to trace, being as sharply defined and accentuated as the older parts of the Tschertschen-darja; which indeed it greatly resembles, the only difference being that the vegetation beside the Ettek-tarim is still living, and in fact shows no signs of incipient decay. Although there are dense forests on both banks, the river-bed itself is bare and empty; sometimes we might have fancied ourselves threading an avenue or wooded defile. The deeper channel in which the current actually ran is still distinct, meandering backwards and forwards from bank to bank. These characteristics continued until we reached the district of Taschtan Kullu, which is reported to lie on a level with the Jäkän-boldschemal on the great Tarim. Thence we turned off towards the north-west, still keeping to the river-bottom; this brought us quite close to the high sand on the west, with dunes 15 to 20 m. high. At the same time the sand on the east grew unexpectedly formidable, and ahead of us, through the now predominant underwoods, we actually saw glimmering, a small mountain of sand, desolate, isolated, barren, rising to an altitude of at least 50 m. At its foot we encamped in a tract covered with kamisch; this we had hitherto



found in only one place, namely in the vicinity of Taschtan Kullu. From this spot a road leads direct to the Jäkän-boldschemal on the Tarim, a path which Toktasin Bek had travelled over, and which, he said, runs through rudimentary scattered sand of no great altitude; in some places the ground is perfectly bare.

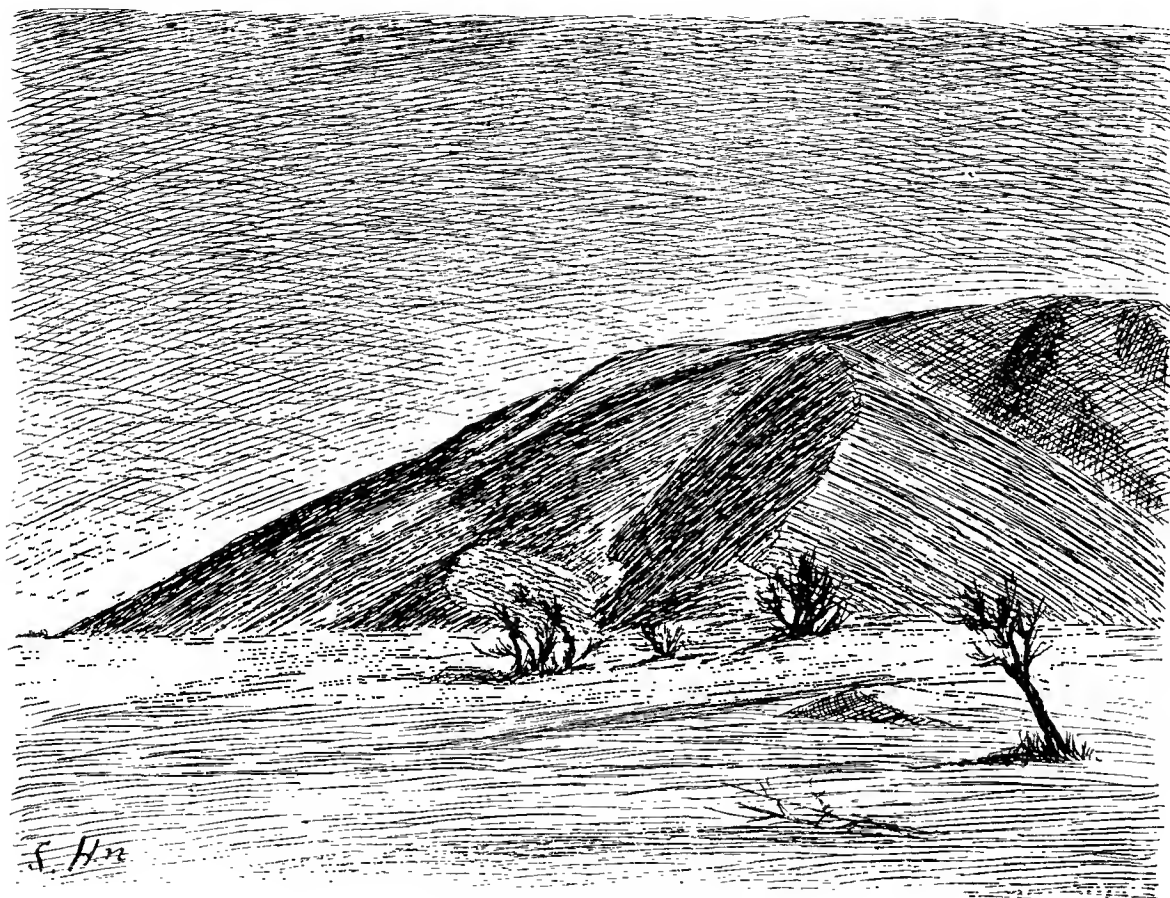


Fig. 359. THE WESTERNMOST PROMONTORY OF TACH-KUM.

Thus our very first day's march of 28.6 km. had been instructive. In the first place, it was evident that Toktasin Bek had not exaggerated when he said, that it is only 30 years since an arm of the Tarim used to flow through that channel: the freshness of the vegetation is sufficient corroboration of his statement. I did not however succeed in learning any details about the river's migration to the east; but judging by analogous instances in the case of the Tarim, it may be supposed that in the beginning a small branch made its way at the side, and that afterwards, at some high-water period, the river flung itself all at once over into the eastern bed; after which the mouth of the western arm became stopped up with mud and sand, and upon this the vegetation established itself, and so augmented the firmness and solidity of the new rampart. Further, at the extreme south of its course we found young forest, but higher up, at the place where we encamped for the night, forest of mature age, a proof that the forest had at some time travelled down the river, thus attaining different periods of growth at different points in the river's course. The same thing occurs again beside the Tarim above Tschigelik-uj. Dead forest does

not however occur anywhere, and the reasons of this are twofold, first the comparatively recent desertion of the river-bed, and secondly the ground-water still existing at an inconsiderable depth. Beside the eastern Ilek, the Schirge-tschapghan arm, and the Ettek-tarim, there grow magnificent woods; but beside the lower Tarim, which winds backwards and forwards between these branches, forest is on the contrary altogether absent. And what is the reason of this? A quite simple one, namely the lower Tarim is so new that there has not yet been time for any forest to grow up. I direct attention to this very instructive circumstance here, although I reserve for a later chapter of this work the proofs that the Kara-koschun is a very young lake; and it is perfectly clear that this lake is in intimate connection with the lowest part of the Tarim. We shall subsequently find that at a time when neither the lowest Tarim nor the Ettek-tarim existed in this locality, the Kara-koschun did not exist either. Finally, it was very interesting to discover sand so high and of such imposing dimensions so close to the east bank of the Ettek-tarim, whilst on the east side of the existing Tarim there is no sand at all.

The sandy swelling at the base of which we encamped is called Tagh-kum (pron. Takkum), a word that must not be confounded with Tokum (= »pack-saddle»), on the Tarim at the same level; for Tagh-kum means »mountain sand», *i. e.* the mountain-like dune I have mentioned. This existed already 25 years before, when the bek travelled that same road in a canoe, though the water was then receding so rapidly that in several places it was as much as ever he could do to float his canoe, and indeed it had to be dragged over some of the »thresholds» which lay across the river. The natives, who are in great part dependent upon their *jajlaks*, or »grazing-grounds», have during the last year or two begun to fear that the vegetation which still remains beside the Ettek-tarim will in time die out entirely, and consequently in the autumn of 1898, that is at the season of high flood, they had endeavoured to divert a portion of the water of the Tarim into the bed of the Ettek-tarim, and so infuse fresh life into the forest and pasture-grounds. To this end they dug a canal at Basch-arghan, which carried water for ten days, but it did not penetrate to any great distance down the river-bed. The experiment was repeated in the autumn of 1899, but this time it proved a total failure, because the river contained only half as much water as in 1898. This was due to the Kirtschin-darja and Laschindarja depriving the Tarim of a great portion of its volume, as I shall relate lower down.

The Ettek-tarim forms a broad valley or trough between two long ranges of barren and pretty high sand. Of these the eastern one turns a steep leeward face towards the valley, while the western range ascends by gentle slopes to the summit of the next dune-accumulation on the west — precisely the same architecture that exists in the interior of the Desert of Tschertschen. The breadth of the actual river-bed varies of course a good deal, and as we advanced on the 16th February it gradu-



Fig. 360. THE TAGH-KUM.

ally increased. Tagh-kum is the highest accumulation of sand beside the Etek-tarim. I climbed to its summit, and a tiring climb it was up the steep, loose, slipping sand-wall that faced the river-valley. I estimated its altitude at 50 to 60 m. The Tagh-kum is an ordinary accumulation of a number of individual dunes which have mounted up over one another's shoulders, turning their steep faces towards the south-west and west-south-west, while the great leeward flank is in general directed towards the west. Although it is lower than the masses of sand we saw in the north of the Desert of Tschertschen, it makes a more imposing appearance than they do, by reason of its standing quite isolated and being surrounded on all sides by considerably lower sand. In fact it towers above the forest like a mountain-peak; it would be impossible to give it a fitter name than that which it already bears. This name was mentioned to Roborovskij, but in his map he puts the mountain in quite the wrong place, namely north-west of the delta of the Tschertschen-darja. There is no part of the desert that bears this name; it is applied solely and alone to the accumulation of sand I have alluded to, which was such a conspicuous object in the eyes of the people who formerly dwelt beside the Etek-tarim and fished in its marginal lakes.



Fig. 361. THE STEEP LEE SIDE OF TAGH-KUM. BELOW IT IS SEEN A PART OF THE ANCIENT RIVER TERRACE OF THE ETTEK-TARIMS LEFT SIDE.

North-east of Tagh-kum there is a moderate-sized bajir, which down to the smallest detail resembles in form and appearance the bajirs of the desert that I have already described. From my vantage-ground on the top of Tagh-kum I could distinctly make out the excentric rings of its successive stages of salinity and desiccation; from these I was able to notice what would otherwise have scarcely been observable, that its deepest part was in the south-east. Here too, as in the case of the depressions which exist at the inner ends of the desert lakes of the Tarim, there exists a narrow strip of vegetation on its northern border. From the summit of the dune-mass the sand slopes gently down to the western edge of the bajir; on its

eastern side it has a steep leeward face, though it is not half so high as that of the Tagh-kum. Were an observer, who had never before seen a bajir, to behold this one, he would infallibly take it to be the basin of an old desiccated lake surrounded on all sides by sand. On the other side of the second sandy ridge the sand gradually diminishes in quantity, whilst at the same time the kamisch steppe increases. In the distance one could distinguish the poplar groves in the vicinity of Schirge-tschapghan, and beyond them again barren yellow dunes of no inconsiderable height, which however do not touch the bank of the Tarim, nor are they visible from it. Thus it is only the western half of the strip of land between the Ettek-tarim and the Tschong-tarim that is filled with sand; the eastern half bears vegetation. This is both interesting and instructive. It proves that, when the Tarim ceased to flow eastwards and empty itself into the Lop-nor, and instead turned to the south, it poured its waters at first undivided through the bed of the Ettek-tarim. So long as it continued to do so, the sand-wave of Tagh-kum was unable to advance, but became stationary; for any sand that chanced to plunge down its leeward side fell into the river and was washed away, and possibly too the river has in places made inroads upon its base. Meanwhile fresh masses of sand were all the time being caught up in the eastern desert and blown west and south-west, and in the form of new dune-individuals they clambered in the usual way up over the shoulder of Tagh-kum, as

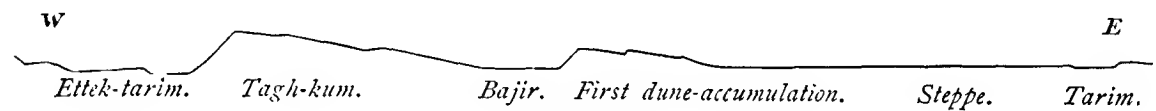


Fig. 362.

well as upon the sand accumulations that lie to the east of it. But when the stream deserted the bed of the Ettek-tarim and flitted over into its existing channel, the supply of sand from the east was cut off, because it was then no longer able, at all events in appreciable quantity, to get across the Tarim. In this way there arose on the right bank of the Tarim, that is to say, west of the river, a zone off which such sand as already existed was swept away westwards, without any fresh sand arriving to make good the loss. Accordingly the ground there is level and free from sand, and is covered with kamisch steppe. Meanwhile the obstacle at the western flank of the Tagh-kum having been removed, the great sand-wave was again at liberty to continue its interrupted march westwards. The question, why there has not been sufficient time, since the river changed its bed, for the sand-masses of the Desert of Lop to reach the left bank of the existing Tarim, is discussed in vol. II. The Tagh-kum has manifestly moved westwards, and this is the only point throughout the whole of the desert region in which it is possible to obtain data, though these are not perfectly reliable, for measuring the rate of movement. Here however we have at least one incontrovertible proof that there has been an advance of the sand-wave towards the west. In one place at the foot of the sand, a place which, it is plain, was formerly washed by the river, the bed, still distinctly traceable throughout, has been buried under the sand. Although it is only a very small elbow, you see it going in under the sand on the one side and emerging on the other. If the river-bed is, as it generally is, about 30 m. broad, and if

it is 30 years since the river ceased to flow this way, we get an advance at the rate of one meter in the year for the entire dune-length. But this result is, as I have just said, not very trustworthy; all we can say with certainty is, that the river-bed has been buried under the advancing sand.

Another fact of great interest is that the Tagh-kum is that portion of the sand-wave which in this region has advanced farthest west; in other words, the highest and most massive accumulation of sand is the one which travels farthest. Throughout the whole of its course this is the only part of the Ettek-tarim which has been buried under the eastern sand-wave, though, it is true, it is invaded by smaller individual dunes. Both north and south of Tagh-kum the river-bed lies at a pretty good distance from the steep sand-wave. I had already observed the same thing in the Desert of Tschertschen, and also beside the desert lakes of the Tarim. Now this appears to conflict with the assumption, that the rate of advance diminishes in proportion to the increase of mass. The explanation which I would suggest is, that the high sand lies more directly exposed to the wind than the lower and relatively better screened portions of sand in its vicinity, and consequently it advances faster. The valley of the Ettek-tarim is also narrowest immediately opposite to the Tagh-kum, being only a few hundred meters broad. Here then there will almost certainly be formed a transverse barrier or threshold, for the sandy slope to the west of this sand-mountain lies relatively in the lee. In all other parts the valley is broader, 3 km. or more. One would indeed have expected that the valley would be broadest precisely where the masses of the Tagh-kum encroach directly upon the bank of the Ettek-tarim, for it is only, or at any rate principally, at this point that the eastern sand-wave has been directly arrested in its westward progress, whilst simultaneously the dune-mass on the west of the river has been able to move unchecked towards the west, whereby the breadth of the valley ought to be increased. That this is not the case however may depend to some extent upon the fact that the Tagh-kum acts as a screen against the wind. But to give a completely satisfactory explanation of the mutual relations of sand and water is impossible. We have not the slightest conception of what the aspect of the country was like when the Ettek-tarim was first formed. Now, it is true, its valley does appear to be as distinctly bounded by two sand-waves as any normal chain of bajirs that exists anywhere in the desert, and it is also very probable that, when the river broke through to the south, it selected a precisely similar chain of depressions, in which it had nothing more to do than clear the transverse thresholds out of its path. But it is also possible, although not likely, that the masses of water forced their way totally irrespective of the position of the sand, and that the two sand-waves, which now shut in its valley on east and west, grouped and arranged themselves afresh after that time. On this assumption, it is easy to imagine that the relatively more westward position of the Tagh-kum, as compared with the rest of the sand-wave, is nothing more than a pure chance.

If the valley of the Ettek-tarim either marks or coincides with a former bajir-chain, then this must at one time have run due north and south, and not south-west, south-south-west, and south, like the chain of bajirs we travelled along in the desert. The valley of the Ettek-tarim bends slightly in three places, thus bringing

the river-bed and its accompanying masses of sand into the direction north-west to south-east, that is at right angles to the line of the prevailing wind. On the whole the Ettek-tarim may be said to lie north-north-west to south-south-east, whereas the great furrows of the western depressions run from north-north-east to south-south-west. Thus they lose their parallelism in proportion as they advance westwards; a deviation being produced owing to the southern portions of the sandy ridges advancing more rapidly than the northern, no matter whether this be due to the relative mass of the sand, the strength of the wind, or the conformation of the ground. As I have already said, Keng-lajka lies 300 m. higher than Jangi-köl; possibly this increase along the line of the prevailing wind is just sufficient to increase the sandlifting power of the wind. The dunes lie, as it were, more exposed, they do not screen one another, which they would do to a greater extent if the surface sloped downwards instead of upwards along the line of the prevailing wind. Relatively insignificant though the increase of elevation is, it must nevertheless exercise some influence.

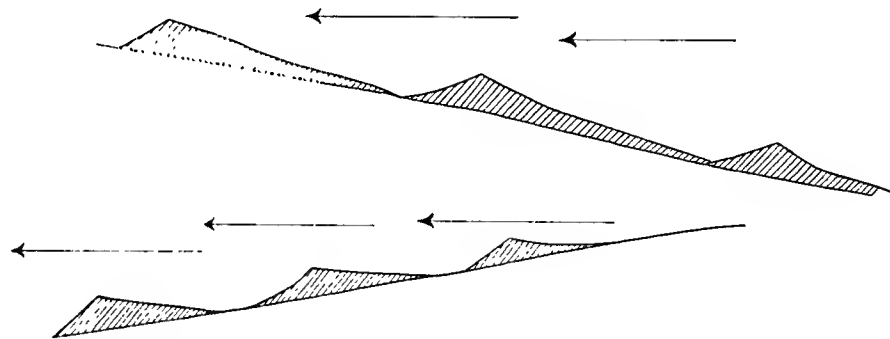


Fig. 363. THE DIFFERENCE BETWEEN DUNES SLOPING UPWARDS AND DOWNWARDS AS COMPARED WITH THE PREVAILING WIND.

Seen from the projecting angle of the Tagh-kum, the zone of vegetation which accompanies the Ettek-tarim presents the appearance of a brown strip, pretty broad, but scarcely winding, across the universal yellow of the sand. Towards its edges the brown colour dies away and finally passes over into yellow. Looking westwards, one sees nothing but an illimitable expanse of sand. Only one bajir is visible, a small one lying due west; all the rest are hidden behind the sand-waves. Now we have found, that the bajir formation exists not only in that part of the Desert of Tschertschen where we crossed it, but also along its extreme eastern margin. It is there that these depressions originate, as well as the sand-waves, and from that cradle of their being they begin their millennial migration towards the west, until they reach the region in which the east-north-east wind is less constant, or alternates with other winds, so that consequently the depressions there become filled with sand, are blotted out, and finally disappear under the overwhelming inundation of the drifting sand. Hence in process of time the valley of the Ettek-tarim will likewise disappear: the sand-wave which lies to the east of it will march on over it, and soon this long trench will become divided, like its congeners farther west, by thresholds or sand-isthmuses into a chain of bajir depressions.

Assuming that the Tarim maintains its present channel for a long time unchanged, what part will that portion of it which flows south have in the further development of the Desert of Tschertschen? We have an indication in the Tagh-kum. Here we have on the left bank of the Etek-tarim a sand-wave 50 to 60 m. high; the next sand-wave on the east of this watercourse is barely half as high; there is no third similar accumulation, only single dunes which soon leave room for the steppe that spreads along the right bank of the Tarim. If now the Tarim checks in this way the transportation of sand from the east, no fresh sand-waves will be able to form, while those which exist already will be carried still farther west, and in the course of time the steppe will gain ground and spread itself out in the wake of the last sand-wave. Whatever may be the course of future development, it may be taken for granted that the sand-masses of the Desert of Tschertschen will suffer serious detriment, and the sandy ridges will assuredly become considerably less than they are now. But, it may be objected, — but how do you, then, account for the Chotan-darja and the Kerija-darja being shut in by similar high masses of sand, — how is it that these two rivers, which longitudinally considered, flow parallel to the lowest part of the course of the Tarim, do not exercise any distinguishable influence upon either the one or the other of the masses of sand which rise on their banks — in a word, how is it these two streams flow transversely across the desert, and yet produce absolutely no effect upon it? I would reply, that, for one thing, these two rivers are essentially different from the Tarim, and so cannot be straight away compared with it; secondly, the winds which blow in their vicinity are subject to quite other conditions; and in any case they know nothing of such a constant and powerful east-north-east wind as prevails in the region of the lower Tarim. Nevertheless, it must be admitted, that the east wind does make itself appreciably felt beside the Kerija-darja. But neither the Chotan-darja nor the Kerija-darja carries water all the year round; precisely in the windy season, that is in spring and early summer, both are perfectly dry, and consequently no longer present any obstacle to the drift of the sand. The belt of forest too is in general too narrow and insufficient to prevent the onward march of the sand, although it does indeed retard it and break the force of the wind. The lower Tarim on the other hand always contains running water, though during the three winter months it is covered with ice. A river which is constantly flowing compels the dunes on the windward side of it to come to a standstill, and of this I obtained a striking proof in the upper course of the Eastern Ilek, where the dunes rise precipitously on the eastern bank, while on the west they have been blown away.

On the 16th February we continued our journey north. The western sand was barren, and in the vicinity of the river not more than 20 m. high; but then we were travelling at a relatively low level and did not see the crests of the sand. Nor were we able to discover any watercourse entering the Etek-tarim from the left, or any gap in the sand, to suggest where in the past the Tschertschen-darja might have flowed; indeed there is not so much as a strip of dead wood to show there ever has been an older channel. In the bed of the Etek-tarim, which all day was marked with extraordinary distinctness, there was surprisingly little sand, at the most only a few small dunes. As a rule, the bottom consists of a bed of hard sand, horizontal or



slightly undulating, or else the loose dust lies exposed. At intervals hard and tolerably sharp-edged cornices of clay jut out, the former erosion terraces. On both sides of the channel dunes are being formed amongst the trees, although it is seldom that they are as much as 3 m. high; but owing to the wind-screen afforded by the forest and the big sand-wave on the east, their formation is certainly slow. The dunes turn their steep faces towards the south-west; the sand-wave turns its steep face towards the west. During the latter part of the day's march the poplar forest gave signs of dying away, the trees became dry and gnarled, and dead trunks were more numerous than they had been hitherto, although they were as yet still relatively rare. The next geographical name we have is Dötö, a word that is stated to mean a straight branch at the spot where a river is divided into two. From that locality the river-valley took us to the north-west. We travelled either in the old bed of the river or on its bank, only losing sight of the former for short distances together. Round about Tokum, a district lying somewhat north of the corresponding locality on the Tarim, the young forest becomes thin, and on the east of the river there are tamarisks growing on high mounds, thus fencing off the eastern sand-wave, which is here at no point half so high as at Tagh-kum. The word *tokum* means »pack-saddle«, but is also said to signify a river-bed that winds in every conceivable direction. From this we may conclude, that the Ettek-tarim was just as serpentine as the lower Tarim is. The furrow of the former now remaining is certainly only the deepest part of the bed, where the actual current flowed.



Fig. 364. VERTICAL SECTION OF THE SOUTHERN PART OF THE ETTEK-TARIM.

The paths we had hitherto seen come to an end in the vicinity of Tagh-kum, for farther north the vegetation is inferior. After this there are no traces, either old or new, of human beings. The district was equally as uninhabited when the bek visited it thirty years ago; on that occasion he too saw neither shepherds, nor fishermen, nor satmas near the river-banks.

It was now quite perceptible, how the forest thins in the west, and grows drier and more meagre in proportion as it recedes from the river-bank. On the bank itself there still survive several vigorous, still living poplars; a short distance from it they have to fight for their very existence, it being just as much as their roots can do to get down to the ground-water; while at the base of the western sand the trees are already dead and withered. In proportion as the forest thins away and grows less flourishing towards the north, the belt of vegetation likewise grows broader, but at the same time scantier, than it is farther south. The trees are of mature age; but in the district of Kurban Kullu-jatghan they present quite a respectable appearance, the biggest toghrak we measured there having a girth at the base of 2.45 m. Here on a small expanse of ground on the east bank there is



a patch of thick and beautiful living forest. One circumstance which is conspicuous throughout the course of the river is that the vegetation on the left or eastern bank is everywhere richer than that on the opposite bank, this peculiarity being particularly noticeable during the second half of the day's march. The reason of this is no doubt the same as that which causes the eastern side of the level floor of the desert bajirs, along the foot of the steep dune-flank, to be bare and protected against the encroachments of the descending sand, whilst the finer particles which the wind whips off the summit are deposited against the western side. Similarly the forest, being under the lee side of the steep dune-wave, is likewise protected against the wind, and its abrading and erosive influence, still further intensified by the drift-sand it brings with it; whereas on the west bank the forest is more exposed to the wind. These conditions are illustrated in the accompanying figure (366). The bigger arrows indicate the path of the lighter particles of sand, the smaller the path of the coarser drift-sand. In point of quantity however the former must be excessively small as compared with the sand which *drops* immediately at the foot of the steep leeward slope, and which is the actual cause of the dune-wave's advance towards the west. The dotted area in the vertical section coincides with the zone in which the effect of the prevailing wind is *nil* or insignificant, and where consequently but little sand accumulates; in the bajirs farthest north we observed that not a single particle of sand has strayed on to these areas. In the valley of the Ettek-tarim, which resembles one long bajir, this circumstance is however less sharply accentuated than in the desert depressions. Its eastern sand-wave is not so high, and the breadth of the valley is greater; besides which the forest must have a certain effect upon the wind and the arrangement of the sand. Hence soil absolutely free from sand is a rarity in this trench.

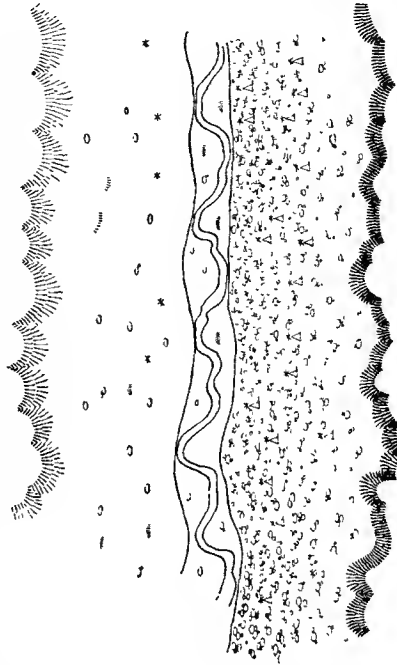


Fig. 365. SKETCH FROM THE ETTEK-TARIM, SHOWING THE FOREST THICKEST ON THE EAST SIDE OF THE OLD RIVER-BED.

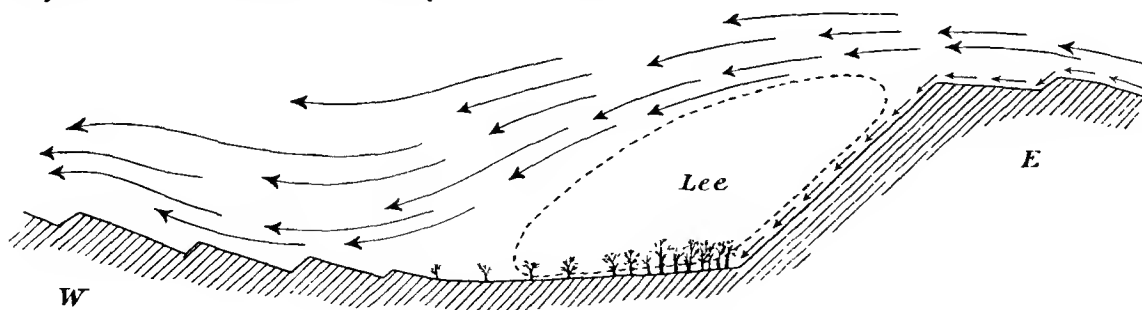


Fig. 366.

As compared with the former Tarim, which emptied itself into Lop-nor, the Ettek-tarim is a relatively recent formation; indeed its existence would appear to have been quite brief, merely a passing episode in the history of the great river;

and to this the forest bears unmistakable witness. When the river first cut a path for itself through this part of the desert, its banks were perfectly barren, and continued so for some time afterwards. But as the water extended, so did the vegetation begin to establish itself. The first to appear is usually the kamisch, and it is not long in getting root on the banks, which it helps to consolidate. Then comes the poplar-forest, which spreads slowly and with great deliberation. Beside the lower Tarim, for instance, it has spread to only a very slight extent since Prschevalskij's first visit, that is twenty-five years ago; since that date only a few very young poplars have succeeded in establishing themselves. The same holds good of the Ettek-tarim, as we can indeed see by its forest. This in the north is vigorous and covers a wide area, but in the south it is quite young, that being the quarter in which it last secured a footing. But the Ettek-tarim retained its position for such a short time, that its southern forest tracts never reached maturity; whereas the northern forest, having struck root earlier, had a longer time in which to grow. Everywhere throughout these desert regions where we find strips of *kötäk* or »dead forest», as for example on the north-east continuation of the Kerija-darja, the banks of the Kuruk-darja, and in several other places which will be described in the sequel, we may be quite sure that water formerly flowed or stood — that there were either rivers or lakes there which have now disappeared.

We encamped on an expanse of hard level clay, absolutely free from sand — the bottom of an old marginal lake. And that there were such lakes is evidenced by names like Julghunlik-köl and Kultschak-köli. This last is of particular interest, Kultschak being a man's name, and the lake which once existed here bore his name because he claimed the exclusive right to fish in it. This justifies the inference, that the district was once inhabited, for Kultschak must have had his hut somewhere near the lake from which he supported himself and his family. Another name, Kurban Kullu-jatghan, bears testimony on the other hand to nothing more than a trivial episode, being a simple tomb inscription intimating that — Here rests Kurban Kullu. Toktasin Bek knew this man as a fisherman from Kara-köl, who, falling ill whilst on the way home from a journey, died and was buried on the bank of the Ettek-tarim.

Here the snow still lay in a few places on the northern slopes of the dunes and under the shade of the trees, showing at all events that the snow-fall had extended thus far. This day the temperature rose to  $+4^{\circ}.2$  C. Spring comes rather swiftly in these regions.

From the tamarisk-mounds beside our camp, which were fully 10 m. high, I enjoyed a pretty extensive view. On the west the sand extends uninterruptedly northwards; on the other hand just at this spot there is a breach in the sand on the east, and it is worthy of note that the breach lies exactly on the west-south-west continuation of the basin of the old lake of Lop-nor, which probably for a long time prevented the transportation of sand from that quarter. Still it is probable that the breach may owe its existence to some other unascertained cause, for on the north of it the sand-accumulations not only continue, but gradually increase as one advances.

On the 17th February we continued our journey towards the north and north-west. Beyond the district of Tokusi-kok-alasi, or the Nine River-arms, the bed of

the Ettek-tarim is choked with bare dunes up to 5 m. in height, situated amongst decaying poplars. The process of sanding up has advanced considerably farther here than it has in the south, and there are dunes on both sides of the old watercourse which we repeatedly crossed as we advanced. Very often we lost sight of this last, either because it is obliterated or else filled with sand, though it is seldom that the sand fills it entirely. Here too, that is in the west-south-west continuation of the Lop-nor, the western sand, that is to say the windward side of the next dune-wave, is for a distance lower than heretofore, though it soon rises again and attains considerable dimensions. Of the forest about one-half is now living, the other half being dead. The roots of the trees, brittle, black, withered, or rotting, twist and twine like snakes over the surface of the ground, and when trodden upon snap with a loud



Fig. 367. A TAMARISK IN WINTER.

report. The ground is as dry as snuff; not a particle of moisture succeeds in reaching up to its surface, not even in the deeper parts of the river-bed. The sand-wave on the east is 10 to 12 m. high, but soon rises swiftly into a continuous crest or wall which is almost as imposing as Tagh-kum. In general the farther north one advances the more desolate and sanded up grows the country, and often a space of barely 300 m. separates the sand-masses on both sides, as though they were threatening to overwhelm the belt of vegetation which lies between them. For a short distance there is more dead forest than there is living. But we were now nearly at the end of this growing desolation. In the district of Tana-baghlaghan the river-bed is unusually deep, and distinctly outlined, and thus far, as is plain to see from the still visible water-line, the canal-water from Basch-arghan, already spoken of, had penetrated the preceding year. North of this point the vegetation again becomes fresher and more

vigorous. Every now and again there is a dried up marsh by the side of the river. Then in a deep spot in the river-bed we came upon a pool 20 m. long, with a snow-covered sheet of ice upon it; this water too was derived from the canal of the preceding year. After that the forest thins away, while luxuriant kamisch beds make their appearance, embracing amongst them a large pool. In the district of Tschapghan-köl (the Lake caused by a Dug Canal), just south of the Tarim, there are old poplars growing amongst the kamisch, thickets, and brushwood. Here at Basch-arghan the Tarim looks so small and insignificant that it is difficult to imagine it is actually the same majestic stream which we had floated down for three full months. It is like a narrow ribbon of ice clasped by the reeds and the forest, and is not visible until you stand on its bank. Since the ice formed in the beginning of winter, the water had dropped 0.96 m., so that the ice was sagging heavily in the middle. The breadth was here only 23.65 m., but at the point where we struck it, it had measured 43 m. across in the autumn. The ice was 0.52 m. thick, and the water which flowed underneath it was practically quite limpid.

Leaving the river once more on our left, we passed through the forest, which is in part old and seems to be more extensive than the forest in the Ettek-tarim, the growth of the latter having been arrested. It is however frequently interrupted by dunes, huge convex tamarisk-mounds, beds of kamisch, sedge steppe, thickets, and underwoods. Here are the two small lakes of Ghadaj-tschapghan and Al-katik-köl. At Ghun-köl, which was frozen, there was a recently inhabited satma. The lake is said to have been formerly 2 to 3 fathoms deep, but is being gradually filled up with mud and drift-sand. We encamped at Arghan or Ajagh-arghan, on the point of the confluence over against the station-house. According to the unanimous statements of the inhabitants of the adjacent village of Tosghak-tschantшти, the river contained then a smaller quantity of water than they ever remembered it to have done: a diminution to some extent dependent upon and mutually connected with the volume of water in the eastern waterway, along which are situated the lakes of Avullu-köl, Kara-köl, etc. The spring-flood was expected to arrive here in the middle of March, and would last for two months; and the autumn flood usually begins in the end of August. The prevailing wind comes from the east-north-east, blows strongest in March and April, and brings with it great quantities of fine sand and dust.

# THE TARIM DELTA



## CHAPTER XXVI.

### THE RETURN JOURNEY FROM ARGHAN TO JANGI-KÖL.

In this chapter I shall relate the incidents of our return from Arghan to Jangi-köl. I prefer to pursue here the course of actual travel, and mention all the geographical names and detailed facts which were successively noted down, and then afterwards (see vol. II) take a general survey of the whole of these intricate and involved waterways. But it would be impossible to follow either my narrative or my reasoning without the map which I laid down during my different expeditions, and which, after being properly worked out, is reproduced in the accompanying atlas. Possibly it may occur to some, that I have entered too much into minute detail, and that it is impossible to see the wood for the trees; but I am persuaded it is important to have these minute data put on record, so that in the future comparisons may be made and conclusions drawn from them.

On 19th February I left Arghan, and pursuing a route that was absolutely unknown, proceeded west, north-west, and north through kamisch steppes, through forest, across what were formerly extensive lake-basins. Having crossed the Tschivilik arm, we followed first its eastern branch, known as the Jemischek-kok-ala (see p. 192 and 193), crossed over this, and then kept on between it and the western branch, which is known under the names of the Jätim-tarim and the Kok-ala. At first the two branches flow quite close together, though afterwards they gradually diverge. At Tschaptschimal there are old, but sound, poplars, and plenty of dead timber. To the south-west we saw the forest which accompanies the Tarim, and beyond it in faint outline the high sand. Then the track turns back to the Jemischek, striking it at a point where it was for a short distance open, and where the water, clear and of a blackish green colour, issued foaming, with considerable velocity, from underneath the ice. After that we crossed by turns kamisch-fields and forest, this last ancient, overgrown, and tangled, with thick, short tree-trunks; and yet it did not look to be so old as the forest beside the Tschertschen-darja. Dead trees and others blown over by the wind, and often matted together in dense thickets, were quite numerous. Shortly after that we grazed an eastward loop of the Jätim-tarim. On the right of the track, though not visible from it, lies the little lake of Sopus-dughan-köli. The next district is Tala-tschorok; and at Tschartma-kotan there is a hut. In the high-water season the extensive and open kamisch-fields of this region are said

to be inundated, though not deeply, by water which overflows from the Jemischek and makes its way into the Jätim-tarim. At that period vast areas of the lowland become converted into a marsh; but the circumstances vary a good deal from year to year in accordance with the varying levels in the different river-arms. Two other small lakes on the right of our route are the Tschong-köl and the Uja-köl, while on the left lies the Bos-köl. Beside the Uja-köl there is a hut. Most of these lakes were at that time dry, though in some of them, e. g. the Bos-köl, there were older depressions containing pools called *tschol*. Further, we noticed on the left Kötäk-tschol and Tus-alghutsch-daschi, a low-lying level bed of salt, surrounded by steppe, forest, and tamarisks; from it salt is extracted. The forest still continued to be in places very dense, with ancient trees; indeed the natives affirm, that this is the richest forest-tract in the whole of the Tarim delta. We ourselves ascertained too that the forests situated farther to the west cannot for one moment be compared with it. From this we may at once infer, that the present main channel of the Tarim is of younger date than these more easterly waterways, and hence that the river, even at this late stage of its course, has shifted to the right.

The next lake on the right, and a dried up lake, is the Suvurghu-mus-kadaghan-köl. It is a striking fact, that nearly all the geographical names in this region end in the suffixes *köl*, *tschol*, or *daschi*; and as an actual fact it is impossible to travel any distance without crossing over former lake-basins or ravines or depressions, which were manifestly formed in time past by flowing water. One native even ventured to assert, that he believed a long time back, say two hundred years, the whole of this region was covered with water, and consisted of a labyrinth of lakes and marshes, connected together by canals and river-arms, which at a later stage of development contracted into a few main arteries and larger lake-basins. Bold though this statement is, and mere vague tradition though the basis is that it rests upon, it is nevertheless not altogether unlikely. When the river first turned south-east and south, it may perhaps have spread itself out as an ever-changing delta, and some time may have elapsed before it settled down into anything like permanent channels. The great number of names, that have as one constituent a word meaning »water» in some shape or form, also points to the same conclusion.

On the left there comes next a dry lake called Tapeldini-köli, while on the right are long lines of low overgrown dunes and tamarisk-mounds. Although a clump of forest shows every now and again, on the whole the kamisch-fields predominate, and often there are patches of ice hidden amongst them, survivors from the inundations. At the next bend, where we doubled the left arm or river, there enters a canal, one meter broad and about the same in depth, which at the season of high flood carries water from the river on the east to that on the west. At the point where our track crossed this canal, and close to the river-bank, we observed a distinctly marked threshold, giving rise to a cataract (*scharkurun*), with a descent of 1.09 m. in height. The canal was at that time perfectly dry. Here then we have a proof, that the eastern arm is more than one meter higher than the western arm.

The Kok-ala arm was frozen throughout, and on its bank were a couple of uninhabited huts, and a third at Kok-aladake-kotan, on its left bank. Young forest is common on the opposite side. At the bend of Jäkän-okuluk-uj the river was 3 m.



deep from the edge of the terraced bank to the surface of the ice, the face of the terrace being vertical or exceedingly steep. After that we saw before us a wide kamisch-field, with numerous patches of ice, covering water which came from the overflow of the irrigation canals of the district of Schejtlerni-osasi, where wheat is grown. After that, again, come Schejtdake-uj and the village of Schejtler, inhabited by three families, while the village of Tägirmän, situated a little higher up on the high left bank of the Jätim-tarim, had two families. Opposite to this last is a low alluvial peninsula. The huts are built in the usual way of reeds: that is faggots of kamisch are raised on end and lashed to a framework of poplar-poles. The inhabitants live principally upon fish, though each owns about a score of sheep, the richest amongst them three score. The fish are caught in the adjacent lakes, not in running water. With regard to Tschivilik-köl, an elderly man gave me the following information, and as these family traditions, even though not trustworthy, nevertheless often serve to point the inquirer in the right direction, I think it well to communicate them here.

This lake, the Tschivilik-köl, is the largest known in the whole of the country of Lop; though in former times it was much larger than it is now. The huts of their ancestors always stood on its shores, and in its *tschapghans* amongst the reeds they used to put down their nets. At a later period the river formed fresh arms and the lake diminished in size; but of recent years it has maintained its area pretty nearly unchanged, though they thought it was getting shallower than it used to be, owing to the deposition of fluvial sediment and to the accumulation of

vegetable matter in its basin. Even in sharp winters it is said to be impossible either to walk or ride across the ice, for there are always places which do not freeze sufficiently to bear. This the people attribute partly to the current which flows through certain sections of the lake, partly to the water in the shallower and more detached portions becoming stagnant (*idik-su*) and slightly saline. The upper stalks of the sedge (*jäkän*) which are left sticking up above the ice when it forms are cut through as soon as it begins to break up, and drifting and packing together into bundles they lie until they rot: these incipient formations of turf are also considered to make the water »sour», and to counteract freezing.

With regard to the west branch, here known only by the common name of Kok-ala, my informant gave me the following *data*: it is lowest in June, July, and August; after that it begins to rise, and is at its maximum in October; and then in November comes the *kömul*, or drift-ice. The ice was said to have formed there that winter in the beginning of December, hence considerably earlier than in the Tarim. It was expected to last for about 25 days longer, but in the lakes for



Fig. 368. SCHEJTLER.

about 1½ months longer. The flood caused by the melting of the ice was looked for about the 20th March, though in this arm it is of less magnitude, and only lasts about ten days. But even when this arm is at its lowest, it does not dwindle into a string of pools, like the other side-branches of the Tarim; but it always forms a continuous and connected stream, though the depth sometimes does not exceed a couple of decimeters. The first season of strong gales, called here »kuschdi-tschangi», sets in in the end of February and beginning of March; these storms bring with them sand and dust, which they scatter over the lakes and the rivers, and so accelerate the thawing of the ice. This season is followed by a period of calm, during which the wild-geese and wild-duck usually return. That winter there had been more snow than for many years previously, the snow lying to a thickness of 1 dm. In May and June it sometimes rains, though that is seldom, and then in short intermittent showers. If by any chance it rains all day, the rain is so fine that it barely moistens the surface of the ground.



Fig. 369. A VIEW OF THE JÄTIM-TARIM BELOW SCHEJTLER.

At Schejtler, which we were to return to on a subsequent excursion, the Jätim-tarim or Kok-ala was 16.9 m. broad at the moment it froze, but at the time of our visit it had shrunk to 9.4 m., and under the ice the water had dwindled away no less than 0.88 m. during the winter. The greatest depth amounted to 2.19 m.; the ice was 0.34 m. thick. In fact there was open water just above the village.

We crossed the river on 20th February a little to the west of the village, and soon came to the lake of Jäkänlik-köl, its dry bottom then covered with luxuriant pasture. We again crossed the river in the district of Bulak. Here, as the name

indicates, there is a spring, which has given rise to a pool, the water of which is strongly impregnated with salt. At the homestead of Tscherik we passed on our left a frozen boldschemal or abandoned river-loop. The great caravan road was about 4 km. away on our left hand, with some smaller dunes between it and us. The Tarim was estimated to be half-a-day's journey distant; that it was an appreciable way

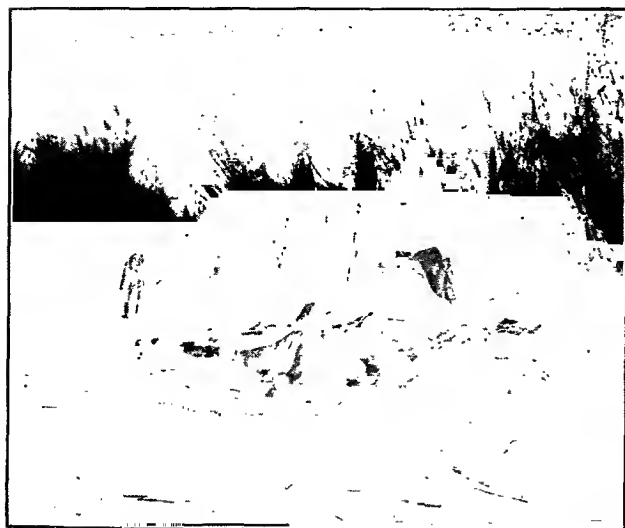


Fig. 370. HUTS IN SCHEJTLER.



Fig. 371. JÄTIM-TARIM AT SCHEJTLER.

off was evident from the fact that we were unable to see the high sand. Ischtan-salghutsch is the name both of a big boldschemal, with a frozen pool, and of a village of several homesteads, which was however deserted 3 years ago, when its inhabitants flitted to Jirim near Karaune, a short distance further west. The boldschemal last-mentioned is said to have been abandoned ten years ago. In the district of Berdischik the path touches the river-arm. Steppe, forest, and tangled thicket alternate with one another; these last make riding difficult and levy tribute upon the camels' hair. Aksakal-köli, on the left of the path, is now dry. The kamisch huts of the next village, At-jegen, on the left of the river, are pleasantly situated in the shade of magnificent poplars. One of these had at the base a circumference of 3.40 m., and was lofty and well-grown, as may be seen from the accompanying photograph. In some of the open reaches of the river there were wild-duck.

On the right of the track comes, next, the boldschemal of Jachija-tschanti-köl, which, although it contained salt water, was nevertheless frozen over. I am told that, as soon as a loop is abandoned by the river, its water becomes salt, even though year after year it is renewed by a fresh supply at the season of high flood.



Fig. 372. A POPLAR (TOGHRÄK) AT AT-JEGEN

This is not the case with the boldschemals of the Tarim; in them the water remains fresh. Probably in the country through which we were then travelling the soil is more saline, especially as it is in the basin of a former lake. The lake of Otok-köl, lying on the right of the track, covered formerly an extensive area, but during the last ten years it has been gradually cut off and converted into a salt-lake, surrounded by kamisch-fields. After that we passed three abandoned loops. Here there were, at the distance of one kilometer to the east, on the west shore of the Tschivilik-köl, dunes covered with vegetation. At the similar dunes of Kara-daj we again touched a bend of the river, and once more, for the last time, in the vicinity of the village of Arelisch. To all appearance the country hereabouts is as level as the sea.

The word *arelisch* is as I have stated above, the same as *ajrilghan* or *arghan*, and signifies the division of a water-way, irrespective of the direction in which the water is flowing. Strictly speaking, it ought to indicate a bifurcation or splitting of a



Fig. 373. POPLAR-TREES AT AT-JEGEN.

river; and that is what takes place at this Arelisch, for the Kuntschekisch-tarim divides there into two arms, of which the eastern goes to the Tschivilik-köl, while the western is the Kok-ala, which we had hitherto followed, and which in the neighbourhood of Arghan is called the Jätim-tarim. The first-named, upon emerging from the southern end of the Tschivilik-köl, is called the Jemischek-kok-ala. The above-named canal between the two streams proves that the eastern arm lies one meter higher than the western arm, a circumstance explained by the presence of the lake. In the latter arm, which does not traverse any lake, the fall is uniformly distributed throughout its whole course, whereas in the eastern arm a good deal of it is concentrated at the little »threshold» where the cataract is. The eastern arm again is much bigger than the other, though only a part of its volume, after it leaves the Tschivilik-köl, is carried to the confluence at Arghan, whilst, as we shall subsequently see, the rest makes its way to the Kara-köl. From what has been said above, it will be evident that the Kok-ala is a very sinuous stream, and the numerous boldschemals which we passed on its left bank appear to indicate that, like the Tarim, it flits to the west; though without an opportunity to examine the right bank, I cannot regard this inference as altogether certain. After the bifurcation the river flows at first north-west before assuming its more permanent south-east direction. The bed is deeply trenched, and narrow like the Ugen-darja; it is amazing that it should so often abandon its loops, seeing that the banks are 3 to 4 m. high. But at the season of high flood, the velocity is so great that the lateral erosion becomes especially powerful. Thus Arelisch is an important point in the intricate hydrography of the country.

We crossed the Tschivilik arm on the ice just below the bifurcation, and then plunged into an old and thick forest full of broken branches and wind-falls which have in the course of time accumulated amongst the trees. Then for a pretty long distance we kept on the left bank of the Kuntschekisch-tarim, or Kuntschekar-tarim as it is called by the natives of Jangi-su, an older river-bed, marked with exceptional distinctness as an elongated hollow fenced in on both sides by dense forest. After emerging from this, the track crosses alternately steppe and bush-covered ground, though sometimes the surface is quite bare and full of hollows and depressions, ancient scarped banks and erosion terraces, left by desiccated lakes and river-arms. A salt pool we came to is known as the Kisil-su. As a general rule the word *kisil* indicates that the water is salt, just as *kara* and *ak* (spring water and water from melted snows respectively) imply that it is fresh. Once more approaching the Kuntschekisch-tarim, we found on our right a very large boldschemal, containing a frozen pool, with forest on its margins. We encamped in the district of Kumluk, where there was a hut standing beside yet another abandoned loop. Thus this river too has left on its banks indications of changeableness, and of its tendency to shift its channel.

Here the Kuntschekisch-tarim, or the Eastern River, is called also the Kok-ala or Ara-tarim, meaning the Middle River, i. e. between the Tschong-tarim and the eastern Ilek. It is fed by two »roots» or »source arms» from the left bank of the Tarim, namely one at Kudshek near Ullugh-köl, the other at Kara-tschatsch below Jangi-köl. But it derives its greatest supply from the Laschin-darja, which joins it over against the above-named Kisil-su. Thus the Kuntschekisch-tarim is considerably smaller at Kumluk than at Arelisch. Of the multiplicity of sources possessed by the Laschin-darja I have already spoken when describing my journey through the reedy lakes of the Tarim. From Kumluk the nearest village, or *mähallä*, is Jangi-su, barely half a day's journey away; the track thither crosses the Laschin-darja and passes through the districts of Kön-asti and Kok-angis. Travelling south-west from Kumluk, you cross three rivers, namely the Kuntschekisch-tarim, the Laschin-darja, and the Tschong-tarim, but travelling north-east you cross one only, namely the Ilek or Bos-ilek. At the high-water season the Kuntschekisch-tarim above the Laschin-darja is said not to rise to the same notable extent as other rivers, which no doubt depends upon the fact that independently of the seasons it derives a pretty steady supply of water from the Kuntsche-darja.

On the 21st February we continued towards the north-west and west-north-west along the left bank of the Kuntschekisch-tarim. The river is discernible only from the thick belt of forest which accompanies it, for the path we chose runs a little distance from it over steppe, and through clumps of forest and excessively trying thickets of tangled bushes (*tiken* and *kongurtschak*). A district beside the river is called Jegren-sulak. The steppe-land is traversed by a narrow winding watercourse, though it was at that time dry. A short distance to the right of the track is an unbroken chain of sandy ridges and mounds, with tamarisks and kötäk. Opposite to Matija-jatghan we threaded our way through a belt of low dunes, which have their steep faces turned towards the west; in the intervals between the dunes there is an abundance of dead kamisch. On the right lies the district of Usagh-kötörma.

At Modschu-kotan the sand-ridge approaches pretty close to the river, the narrow space between the two being filled by a belt of very dense and tangled toghrak forest, where it was extremely difficult to travel with the camels. After that we clung as closely as we could to the northern bends of the river, for the sandy ridge gradually deviated from the track, though it never got out of sight, but was always distinctly visible and clearly outlined. This sandy ridge is the south-west edge of the belt of desert that I crossed in 1896 on my way between the Kuntschekisch-tarim and the Ilek. The entire space between the river and the edge of the sand is occupied by kamisch. The sand, which is in part bound together by vegetation, has



Fig. 374. TOGHRAC OUTPOSTS BETWEEN THE DENSE FOREST AND THE KAMISCH-FIELDS.

no doubt been prevented from reaching the right bank of the river by former lateral branches which have now disappeared. And of this we found a proof, along at all events one part of the distance, in the little frozen arm which enters the first loop after leaving Modschu-kotan, and in which, winter though it was, water was still flowing. It comes last from the Jäkänlik-köl, a shallow marsh, full of reeds, which in its turn is fed by an arm that issues from the Ilek at Söru, and in this way carries water from the Kontsche-darja. At the spot where the little feeder entered there was a belt of open water near the bank; but elsewhere the river was frozen over, though the ice was then a good deal thinner than it had been.

Somewhat farther on we passed yet another branch from the Jäkänlik-köl. This was stationary and frozen, having had no current for three years past, owing to the drain made upon it to feed the canals that water the grazing-grounds in the vicinity. After that the left bank is called Mandschar, the right bank Jirim. At Tschawal a canal goes off on the right and drives a mill, while on the opposite side of the river there are several similar canals, then indeed dry, though they are all used in the autumn for grinding corn. The scenery consists after that of extensive steppes and tangled thickets and bushes, dotted over with solitary young poplars and low tamarisk-mounds; though close to the sand the poplars are more numerous. In the next district, Kirtschin-kotan, I encamped in 1896. In another district on the right, bearing the name of Baban-ullughu, there is a boldschemal containing foul and evil-smelling water. Chang-gung, on the right bank, is certainly a modern Chinese name. Farther on in the same direction is the (then) dry lake of Bos-köl. Far away towards the north a dark line of poplar-woods marks the position of the Mengligi-ilegi, or the Ilek, a continuation of the Kontsche-darja, which I discovered in 1896. Having crossed over a branch issuing from this last at the point where it enters the river, we proceeded across the extensive marsh, only in part frozen over, which stretches beyond. In this swampy tract, which grows an abundance of kamisch, there are veritable islands of sand, one to two hundred metres in diameter, and bearing a few scattered poplars. One of these islands is known as Islam Jussul-uji, and contains the ruins of an old hut. The distant river-bank is called Matija-sörötmesi. From Abdal-tschapghan there goes off an irrigation canal to water the fields of Dural. The next arm from the Kontsche is deep and narrow, and is spanned by a bridge, being underneath the bridge only one meter broad; and the water was flowing under the ice that covered it. We saw the houses and homesteads of Dural a little distance away, and then pitched our camp at the next bend of the river. The forest here is poor and thin, and the trees young. We observed shepherds' encampments at four places on the river-bank.

One day's journey north-east of this place there is said to be in the sandy desert a masar known as Chodschaji Kisi-masar, its position only indicated by a number of streamers on poles. Hence to Jing-pen it is accounted a two days' journey, through a desert in which there is no trace of old river-beds, except at Jing-pen itself, where one runs eastwards\*. During the year preceding the Kontsche-darja had very appreciably lost volume. This loss was said to have been caused by the newly settled Kara-kum, midway between the Kontsche-darja and Schinalgha, having drawn off from the river one-third of its volume to irrigate its newly broken fields. The place is stated to be inhabited by 3,000 Tungans, gathered from different quarters, but consisting in great part of fugitives, who, after the revolt of 1896, fled westwards and were compelled by the Chinese authorities to found the settlement of Kara-kum. These new colonists, then, are held to be responsible for the decrease in the river; though the canals are closed during the winter months.

As for the Ilek, it runs highest in spring, when the winter-ice breaks up in the Bos-köl, Maltak-köl, and Turkomak-köl, and after that the river drops consider-

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\* This statement is however doubtful. See vol. II.

ably. These three lakes are connected together; in fact, they are, properly speaking, one, although separated from one another by impenetrable reed-brakes, which prevent canoes from passing from one to the other. There is said to be a broad strip of shore on their east side between the water-line and the sand. The biggest river in this district is the Laschin-darja, which carries water from the Tarim to the Kuntschekisch-tarim. Ten or fifteen years ago the Tarim was incomparably the bigger, whereas the Laschin-darja was an insignificant stream; but since then the relations have gradually been reversed. A couple of years ago a branch of the last-named formed a lake at Dural, from which the people of that place used to derive water to irrigate their fields; but in consequence of some alteration in its bed this channel ceased to carry water, so that great injury was done to the people's agriculture. As a result of this the population decreased, until Dural was then estimated to consist of only 30 *ujlik*\* or households, of 5 individuals to each. The greater part of these are poor folk from Turfan, who have taught themselves to cultivate wheat, maize, melons, etc.



Fig. 375. A »TAM-UJ» OR CLAY HUT AND A »SATMA» OR KAMISCH HUT IN NEW TIKENLIK.

Just above Kumluk a third arm enters from the Kontsche-darja; it was then flowing, the stream being deep and lively, and free from ice; hence we preferred to cross on the ice of the Kuntschekisch-tarim and then keep along its right bank. The river was 73 m. broad. Travelling west-north-west, we passed on the left Muhamed Nias-tschaderning-uj, and on the right, on the other side of the river, the southern extremity of the Maltak-köl; the inconceivably vigorous and tall reeds that fill the lake appeared in the distance like sand-dunes. It is from this part of the lake that the large Kontsche-arm issues which in 1896 I crossed on a makeshift ferry. In one of its boldschemals we found salt water still remaining. After that we crossed over the basin of a lake, which dried up long ago, leaving an unmistakable depression, and itself surrounded by well-preserved and exceptionally distinct shore-lines and lake-margins. The place is called Attamni-dschajiri, and is now traversed by the great highway from Dural, as well as by an arik, the Ak-katik-arik, dug three years ago. It is this which has given origin to the marsh that occupies the lowest part of the depression. On the left side of the river is the old village of Tikenlik, which I visited in 1896, and farther away the Bos-köl, one of the Maltak-köl lake-complex. Keeping along the right bank of the river, we crossed over the head of the Ak-katik-arik, as well as over another canal provided with a bridge. The banks thereabouts are very bare; it is quite a rare thing to see a young poplar, still less to see two together. After that we passed the point where the deep-cut branch that leaves the

\* By one *ujlik* is in general meant the number of persons who eat out of one and the same *kasan* or *pan*. This number may vary from 2 to 20 persons where the sons of the family are married.



Tarim at Kirtschin (see p. 176 above) enters the Kuntschekisch-tarim. The current in this branch was quite lively, and its water as bright as crystal; evidently it had traversed lakes in which it had discharged the sedimentary matters it carried with it. In this locality, Tschigelik, we observed several kamisch huts and arable fields, though these were then sheeted with ice. They had been cultivated by the Tungans before they moved to Kara-kum; but since then they have been in the hands of the Chinese, who in the cold season of the year live at Dural.

Immediately beyond the new Tikenlik we crossed over the Kirtschin branch by a small bridge, and found that on its left bank there were also cultivated fields and irrigation canals. Leaving this branch and the great highway successively on our left, we struck into a smaller path leading north-west to the Kuntschekisch-tarim, the banks of which, here called Tschapal, are sparsely dotted with poplars. The soil between the two rivers is incrustated with salt, with tamarisks dotted over it. According to my guide, there was at this place some 40 years ago or so a large lake. Next we came to the end of a side-path from the older Tikenlik. A hill on the left, called Kalmak-tüschken-dung, points to its having been visited by Mongol (Kalmuck) pilgrims. Here too, at a sharp bend of the river, was a frozen bold-schemal known as the Niasmetning-kok-alasi. The names Kaltschi-tokkan and Kitaj-chat-kaldi are given to a patch of meagre forest on the left bank of the river. Then comes a sand-hill, Tömur-kose, virtually surrounded on all sides by the winding river. On the south bank lies a desiccated lake, the Säfär-kasi. Once more we crossed the river on the ice near Kurban-köli, beside a lake that disappeared about 15 years ago.



Fig. 376. OUR CAMP AT TURDUNING-SÖRESI; TO THE RIGHT IS KUNTSCHKEKISCH- OR ARA-TARIM.

The river at this spot is not especially large; indeed in May and June it is said to be dry, and to remain dry until the high-water comes in September. This stream originates at Kuslik, and only becomes of noteworthy dimensions after it has been joined by the Kirtschin branch and the Laschin-darja; it is only above their confluences that it dries up in the height of summer. Our camp was called Turduning-söresi. Here there are poplars, though young and scattered; but tracts of larger and better grown forest are said to stand between the Kuntschekisch-tarim and the Tschong-tarim, where they have been left in the lurch by the river-arms. In this locality our river is generally called quite simply the Kok-ala; its volume is said to have decreased in the last thirteen years, especially since the Laschin-darja became the premier stream of the neighbourhood.

On the 23rd February we travelled a good distance away from the Kok-ala or Kuntschekisch-tarim, and entered the overflow area of other streams, periodical overflows being pretty common in this district. Beside the river are sparse poplars, and every now and again we would pass a cultivated field. The Tschöl-ottogho-tarim,

which joins the Kok-ala in the district of Tasch-tschukan, was abandoned 4 years ago, and is now completely dry. This we had for some distance on our right, though afterwards it flowed further away, its channel being bordered throughout by old and luxuriant forest. There exists also flourishing forest beside the Kok-ala opposite to this same region. Then we had on our left an almost perfectly bare zone of sand, except for a little extremely sparse vegetation, with every now and again a dead tree. On the right we left an old dry boldschemal, which some time or other was destroyed by the Tschöl-ottogho. After that the track led through an almost barren sandy belt called Kum-tscheke, and finally it took us away from the Tschöl-ottogho, which is reported to be half a day's journey distant from the Kontsche-darja. The undermentioned places are said to belong to Tschöl-ottogho, — Dovlet-tareghan, Arsemet-kätgen, Kum-tok, Laschin, Oghru-tschapghan, Kultu Bekni-uji, and Dalal-uji, which is reputed to be the origin of Tschöl-ottogho. On the other hand I was unable to obtain any clear information as to *where* precisely this origin is; all I could glean was that formerly the stream in question separated from the Kok-ala at the last-mentioned point, situated somewhere above Kara-dung (see below). The district of Jaman-tala bears indications of having been once cultivated, as also of canals that derived their water from the Tschöl-ottogho. At Jigdelik we again touched one of the bends of the Kok-ala. On the north the forest-belt of the Tschöl-ottogho was now screened by a zone of barren dunes, of very respectable elevation and size, which turn their steep faces consistently towards the west-south-west. Here then we have an actual, though narrow, strip of desert sand between the Kontsche-darja and the Tarim. The district lying immediately north of the forest of Jigdelik is called Jaman-talaning-baschi. The track we were following, which had by this returned to the vicinity of the Kok-ala, is so seldom used since the Tschöl-ottogho dried up, that it is in many places obliterated, especially where the soil consists, as it often does, of sand. On the left, near the river, is the district of Nodsche, while on the right is Tölögön-tareghan, being, as the name indicates (Tölögön has been Sowing), formerly a cultivated locality. Not only does the nomenclature point to this region having been formerly more densely peopled than it is now, but in several directions, even where the localities bear no names, there are rectangular ridges and depressions, plainly indicative of fields long forgotten about. In this land of incessant change even the arable ground is, we see, of temporary duration only. Let a river but alter its direction, and the irrigation canals which go out of it dwindle away and the fields they watered dry up, and are abandoned. Here the population have no alternative, but have to follow after, and dig new canals from the banks of the new channel.

After passing Kurban Kullu and Tölögön-tareghan-baschi, we doubled a sharp bend of the river, the river itself inclining away to the south for a good long stretch. The name Urusgha-sal-salghan (the Ferry built for the Russian) points to a passage of the river by some Russian traveller. Twenty *jöl* south of our route our Kok-ala (that begins at Kudscek) unites with the arm which starts from Kara-tschatsch, and runs south of a pretty extensive, but barren, belt of sand. In other words, the Kok-ala or Kuntschekisch-tarim possesses two main head-streams, both issuing from the left bank of the Tarim. Beside the Kudscek branch lie the districts of Barat-uktesu, Kum-arik, Toschkan-salghan, and Akma-salghan-köbruk; while beside the Kara-

tschatsch branch stands the village of Tschigelik, a *kischlak*, or »winter village», with 30 ujlik, the summer quarters (*jaslak utturghan*) of its people being at Kusch.

Then for a considerable distance we travelled across a wide-spread overflow region, manifestly once a lake-basin. In one place we perceived signs of cultivation, and indeed it was only given up two years ago. Further on we encountered two huge patches of ice, backed on the north by bare sand of considerable dimensions. The cause of the district being inundated is a canal which was originally constructed for the purpose of watering the fields in question; but nobody has now any interest in stopping it up, and so preventing the inundations. The two sheets of ice I have just alluded to are called Davaning-köli, a name which points to the presence of a former lake. A strip of sand to the west of them is known as Davan, or the Pass.

Once more we struck the river in the district of Töttöru. Its banks were planted with excellent forest, in which there were frozen sheets of water. We crossed the river at Apis-angesi, the ice being still quite strong. Curiously enough the forest, dense, luxuriant, and aged, is confined to the left bank, while on the right or southern bank there are only kamisch and tamarisks on their characteristic mounds. Our guides assured us, that as far back as the memory of man could go the river had preserved its existing course, and this is corroborated by the age of the forest. The fact of the forest being confined to the left bank only may be purely accidental. To the south stretched open steppes, so that there was nothing to prevent our uninterrupted view of the gigantic sand-dunes which fence the right bank of the Tarim, barely half a day's journey distant.

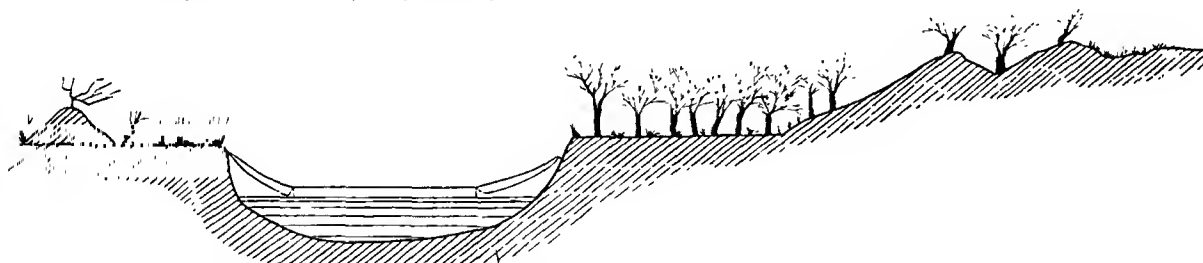


Fig. 377. THE KUNTSCHKEKISCH-TARIM AT APIS-ANGESI; IN WINTER THE WATER HAS FALLEN CONSIDERABLY AND THEREFORE THE SURFACE OF THE ICE IS CONCAVE.

The name borne by the little village of Kara-dung on the right bank, a place of 4 ujlik, is significant of the very numerous dark tamarisk-mounds which exist there. The track next crosses over the isthmus, or »root», of a north-going loop, and then a stretch of steppe, which is likewise traversed by three ariks, that supply Tschigelik with water from the river, though they were then ice-bound. The steppe was dotted over with little frozen pools, filling small round hollows and encircled by salt-rings. Taken as a whole, the soil has a very appreciable impregnation of salt. Once more we crossed the river, on the ice, at a point where it is touched by the great highway, the Kan-joli, or King's Road, and encamped in the district of Kurm-uj on the left bank.

Upon comparing the Kok-ala with the branches of the Tarim that lie southwest of it, one cannot entertain the least doubt as to the relative ages of the two rivers. Alongside the former there exist old and magnificent forest; whereas beside

the latter the poplars are both young and few in number. The bed of the former is deeply and energetically excavated, and its high steep banks keep the water within reasonable bounds, except when it overflows at the season of high-flood, and this is extremely seldom; whereas the Tarim is a broad and shallow stream, with shifting banks. In a word, the Kok-ala is older than the Tarim, and without doubt served as the channel for the whole of its flood at a time when the present main channel did not exist, and when the lofty masses of sand in the south-west perhaps reached as far as the right bank of the Kok-ala, in the same way as they now overhang the right bank of the Tarim. When one sees, as in this region, several more or less parallel rivers possessing serpentine beds excavated to irregular depths, it is impossible to dissociate from one's mind the idea that they really do represent successive stages of the main bed of the Tarim, or, in other words, that each of these in turn did for a certain period serve as the principal artery of the entire hydrographic system, and as the outflow for the entire mass of its water, or at all events for the greater part of it. During that period they excavated their beds so deeply that they still continue to carry water even though the main stream has flitted farther to the west. As in the case of the Ugen-darja, it is only the deep winding trench of the actual current that now survives; those parts of the general bed in which alluvium was deposited are now overgrown with vegetation, and held fast by its power of detaining drift-sand and dust. Very often this is evident at a glance.

Approximately south-west of Kurm-uj lies a series of lakes — Arpa-kumghundung, Talaschtik-mughu, Soghujtschagh-jatghan-kotan, Pavane-kotanu, Ak-köl, Bolto, Matijasi-togh, Matijasi-kotanu, Toj-bolghan, Sejt Asarni-ilegi, Janijas-jatghan, Dungutuvu, Ottok-köl, Ullugh-köl, Chodschem Värdis-köl, Üssüpü-jajiri, Jaman-jajir, Örlesch, Scharkurun, Konkolluk, and Schama-tschapghan. These are traversed by the Kudscek arm, which at the same time supplies them with water. The actual series terminates with the lake of Scharkurun, from which the river issues in the form of a narrow *ilek*, while the two lakes last-named lie at the side of the series.

The natives of the district of Tikenlik told me, that the *aghis*, which is spanned by a bridge (vide pp. 159—160) not far above the Jangi-köl, was once the main stream of the Tarim. Although I have never visited the locality myself, and consequently am unable to answer for the correctness of this information, it nevertheless has the appearance of being correct, especially as I obtained incidental corroboration from various other sources. I will therefore record here the results of my inquiries. The river in question is said, then, to have divided immediately below the existing bridge, each branch diverging to its own series of lakes, of which all are now dry, except the first three. All the same, traces of their former basins are still easily discernible, and the former existence of stationary water is proved by the character of the soil, which is either bare or sparsely dotted with steppe plants. Add to this, that the names still remain. The left or northern branch went to the following lakes — Jaghatsch-alghutsch, Tongus-jardi, Kärälik, Tajir-jajiri, Tenger Kullunu-uji, Döschötu-arghaji, Köldölön-köl\*, and Tughu-baschi, where the branch entered the Kontsche-darja.

\* This is the name given to every elongated lake which extends at right angles to the water-course that traverses it.

The right or southern arm traversed the following lakes — Kara-basch-salghan, Jäschil-köl, Gurkur, Dschan Kullu, Odschuluk-köl, Ghudschek-sapi, Ilek, Jäschanglik-köl, Karani-kadasi, Karaunelik-köl, Ukarlik-köl, Bajir, Julghunlik-köl, Baki-kamisch-urghan-köl, Togghoro-darja (the Straight River), where the arm in question enters the Kontsche-darja. Certain of these terms are manifestly not the names of lakes, e. g. Gurkur, which means »waterfall» or »cascade», and Ilek, which signifies the connecting link between two lakes. Another *ilek* is reported to have connected the Dschan Kullu and Odschuluk-köl. Bajir was a salt lake; plainly because it was not touched by the flowing current, but must have been a detached pool lying by the side of the stream. This name is however so far forth interesting in that it seems to suggest, that the natives look upon the bajir depressions in general as desiccated lake-basins. The distance between the mouths of the two branches was estimated at a day's journey. It was also a day's journey from Aghis on the Tarim to Tughu-baschi, and from the same point two day's journey to Togghoro-darja. Hence at the period alluded to the river broke up here into several arms after the manner of a delta. Now the relations are reversed, and these several diagonal rivers, starting in divers different places, gradually converge, precisely as we have seen in the case of the Kuntschekisch-tarim. The largest of all these lakes is said to have been the Jäschanglik-köl, which lay next the Kontsche-darja. To ride round it at the gallop took a whole day. At the present time its dry flat basin is open towards the Kontsche-darja, but in every other direction it is bordered by low dunes. About two hundred years ago it was possible to row from Soghot (see below) *via* the Togghoro-darja to the Tarim; so that the intervening portion of this old waterway has now disappeared. At that time the Tarim joined the Kontsche-darja a good deal higher up than it does now; and at a period still earlier the junction was effected, as I have already stated, higher up still, namely at Tschong-köl and the Intschkä-darja. Just at the time of my last visit the junction was on the point of making yet another step towards the south, in consequence of the Laschin-darja gathering into itself the main flood of the Tarim.

Thus the region between the two now dry river-arms used to be filled with a number of lakes and marshes, or rather it was one large lake, with occasional interruptions, similar to what the Kara-koschun is now. Probably at that time the latter did not exist, but came into being when these northern lakes dried up; that is to say, the lakes travelled down the Tarim in the same way as they now show a tendency to travel north again. The Lop-men of Tikenlik are convinced, that at the time when the Tarim flowed through the two series of lakes, the present Tschong-tarim did not exist from the district of Jangi-köl southwards, and in proof of this they point — and they are in many respects shrewd, clear-sighted men — to the fact that the forest beside the Tschong-tarim consists of young trees only, and that, had the river occupied its present situation for any great length of time, the sand on its right bank would have been carried farther to the left. This is also my own opinion, for which I have already advanced my reasons. In many places moreover the old river-beds are indicated by driftwood, which still remains sticking up out of the ground. Seeing then that the changes in the hydrographical system have been so great in such a brief space of time, there should be nothing to surprise us when we find that, as I shall subsequently prove, they have been

very much greater in the course of the last 1600 years. The lines by which these waterways are represented on the map are but fugitive and of temporary duration, as may be seen from a comparison of my map with Przhevalskij's. In the course of only 25 years material changes have taken place, not only in the volume, but also in the relative positions of the several arms one to another. How indeed can it well be otherwise, in such a flat and level country, with a soft, loose soil, consisting as it does of sand, clay, and dust, which is unable to offer any serious resistance to the masses of water and their powerful erosive energy?

At the moment of writing the rain is pattering on the roof of my villa, from which a sand-strewn path, two meters broad, leads down through the garden to the sea-shore. The path being slightly convex, the rain-water is forced to divide itself into two rivulets one on each side. At a bend in the path some diagonal runnels cross from the inner rivulet to the outer. Lower down these temporary currents gather into one, which forms a small pool or puddle close by the shore. During the course of the day I have watched with great interest the changes that have taken place in this miniature hydrographic system, which in many respects reminded me of the Tarim and its lakes. It was a striking laboratory experiment arranged for me by the rain out in the open air. Even the marginal lakes on each side of the rivulets were not wanting. In virtue of their erosive power, exercised in and upon the loose sand, the diagonal runnels between the two principal currents changed their positions several times during the course of the day. In one place one of the two rivulets shifted its own position in consequence of a ridge of mud which it had itself cast up. The last main artery, with its muddy water, continued to augment the sedimentary matter in the pool at the end of its course, and if only the rain continues long enough that little basin will be filled up, and when that happens a fresh pool will form beside it or a little way off.

Who is there who has not hundreds of times watched these tiny rivulets of rain-water making their restless way through the sand? Precisely what I have here briefly described in miniature is what takes place in the Tarim delta, only on an immeasurably greater scale. But the laws which govern the water and the effects of the slope upon it are the same in both cases alike.

On the 24th February, leaving the river on our left, we struck through a forest region, where there were dense *kamisch* and steppe, interrupted at intervals by small »insular» elevations of sand or dust. On the left we had the districts of *Avul-päs* and *Tscharvalik*, and on the right *Dukan-tusu*. At the second of these places there was a *boldschemal*, for the most part hidden amongst the reeds. The river is however not far distant, being easily traced by its accompanying forest, and beside it is the tract of *Kuntschekan-köbrughu*, a name indicating that there either has been or now is a bridge there. To the north of our route stretch *ala-kum*, that is »sporadic dunes», all the way to the *Kontsche-darja*. The next names are *Satin-angesi* and *Köruk*. To the north is the old mouth of the *Togghoro-darja*, though its immediate surroundings are masked by a belt of low sand. At *Tschinagh-jatghan-tschol* we again approached the river-arm at a sharp bend, whence three canals, spanned by bridges, go off to some cultivated fields that have been only recently given up. At the next succeeding bend, *Tallik*, we once again struck the great caravan road,

after it had shortly before crossed over the river by a bridge. Then came an elongated boldschemal, Bos-köl, surrounded by thick reeds and containing water. The track hugs closely its northern bank, keeping along its former erosion terrace, 1½ m. above the level of the water (see fig. 378). Now the existing river possesses no erosion terrace so distinctly and so deeply carved as this, nor could a boldschemal of such depth have been formed except at a period when this channel carried the main stream.



Fig. 378.

A short distance to the north-east is the lake of Julghunluk-köl. At Barkeniarghaji there is a masar, with a sepulchral monument of clay of an unusual character, being in the form of a small terrace, with a number of semicircular curves like handles on its horizontal surface. To the south is a small patch of dunes, bound together by vegetation and known as Kara-kir. After that we reached the village of Ak-tarma, the principal place in the *tabäsi*, or administrative district, of Ullugh-köl, which is said to embrace 30 *ujlik*. Eight of these are in Ak-tarma. Beyond this village, again, there are some old abandoned river-loops, some with, others without, water. On the right of the track lies the lake of Karaunelik-köl, almost exactly opposite to the Tarim lake of the same name. The next bend of the river is called Tarascha-kotan, and in the same neighbourhood is Tungan-tüschken. On a steppe diversified by small tamarisks, without the usual mounds, we found the burial-place (*ghuristanlik* or *saratlik*) of Masar, as it is simply called. The soil hereabouts was everywhere impregnated with salt (*schor*); it is evident it was formerly a lake-bottom. To the north of the Tarim stretches a long, narrow belt of forest (poplars), marking beyond all doubt the site of an old river-bed, now long vanished.



Fig. 379. HOUSE IN THE VILLAGE OF AK-TARMA.

At Idek-ilek, a river-bend encircled by poplar woods, the great high-road continues on towards the north-west, whilst we struck into a smaller track leading west-south-west. North of this lies the salt pool of Ävulluni-daschi, and near it is a solitary grove of poplars known as Haser-ölgen. Here too are the two cultivated districts of Tongusluk and Nias Supa Bajning-uji. At the point where we turned away from the great highway we crossed the little stream of the Idek-ilek. This, known higher up as the Jaman-ilek, is said to start at Arelisch, just below Aghis (see above, p. 160). In this particular locality the hydrography is more complicated than

ever. The branch which comes off at Kara-tschatsch divides in the district of Tongusluk, the right branch being that beside which we travelled for so long, while the left branch joins the Jaman-ilek. The latter branch appears to be a double stream, or to possess in its lower course a divided bed, for although the confluence usually is at Tarascha-kotan, in the season of high-flood it takes place at Tongusluk. Formerly the stream used to enter the Karaunelik-köl, but that lake has dried up since the river ceased to discharge into it. The Jaman-ilek is excessively winding, and appears to be one of the rivers which is on the point of disappearing. It still carries water, it is true, though only a very small quantity. We again crossed this stream at Ävulluni-toghu, a district distinguished by a magnificent forest of tall, handsome trees. The name I have last cited indicates that a man named Ävul built here a dam (*togh*) for the purpose of procuring water to irrigate his fields near the river. Next comes the lonely homestead of Atta Kullunu-ottogho, buried in a poplar-grove. To the south we once more had glimpses of the poplar woods beside the Kara-



Fig. 380. NATIVE WOMEN.

tschatsch branch and the canal of Kosch-arik. We left the Jaman-ilek on the right at the homestead of Chodschem Kullunu-ujji; its situation, as well as its age, which unquestionably is greater than that of the Tarim, are indicated by the belt of forest we saw in the distance. This same stream is again crossed by the great highway at the *örtäng*, or »rest-house» (caravanserai), of Dschan Kullu. At the present time the Jaman-ilek appears to issue into the Kok-ala at Tarascha-kotan, but it is doubtful whether its feeble current ever manages to get

as far as that. Just above our headquarters a little canal goes off and turns a mill at Tägirmän; while immediately below it is a cluster of tamarisk-mounds known as Mahmet-tschekan-dung.

The following days were spent at our headquarters camp at Jangi-köl, in making preparations for our next excursion. Meanwhile an unexpected change took place in the weather. The first real *kara-buran* of the year sprang up on 25th February from the east-north-east, bringing with it clouds of drift-sand and dust. We lost sight of the stupendous dune-wall which overhangs the right bank of the Tarim, although it was not more than two or three hundred meters distant, so thick was the dust-haze. This was unquestionably the signal for the mighty dunes to begin their annual westward march. On the morning of the 26th it began to snow pretty thickly, not in flakes, but in round, hard pellets, which rattled audibly on the tent-cloth. The ground, which had of late been quite bare, was again covered with a continuous sheet of white, though in the afternoon, when the sun peeped out, the snow melted in all exposed situations. I have frequently observed that, when there is here a downfall of snow, it generally follows immediately after a storm from the



east; and the same observation holds good of the rain in the spring and summer. It was only when this after-sting of winter had passed that spring really began. That year December, January, and February were all hard winter months, and November was pretty cold.

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## CHAPTER XXVII.

### THE SCHIRGE-TSCHAPGHAN BRANCH AND CANALS.

This ends the description of my journey in the winter of 1899—1900. I have described it in chronological order; but this arrangement is less suited for the excursion which I undertook during the warm months, and which embraced the southern foot of the Kuruk-tagh, the Kuruk-darja, the Desert of Lop, the Kara-koschun, and unknown parts of the delta of the Tarim. In this case it will be more convenient not to be tied down to the chronological order, but to begin with that part of the excursion which belongs geographically to the region I have already described.

We had encamped on the left bank of the Tarim, opposite to Jurt-tschapghan, at the same spot where on two or three subsequent occasions we were to pitch our tents again, so that this place became one of the most important centres during the whole of my journey — important both topographically and astronomically. The problem which I now had immediately before me was to ascertain the existence and course of the recently formed arm, which begins at Schirge-tschapghan and terminates in the Kara-koschun, at some point below Kum-tschapghan. I had corroborative information as to its existence from various quarters. The first question was, how we were to get our canoes over to it from the Tarim, for the banks of the new stream are uninhabited, and its labyrinthine entanglements are known to nobody except a few hunters. But this difficulty was easily overcome by harnessing our camels to two canoes, each properly loaded and big enough for three men, and dragging them overland. I was thus accompanied by four Lop-men, who knew the country, and by one of my Cossacks, and we took with us provisions to last four days.

We started on 14th April, and proceeded at first towards the west, then towards the north-west. The country immediately adjacent to the bank of the Tarim was an extensive marsh, upon which the natives turn their irrigation water, to freshen up the kamisch grazing. After that we traversed a patch of living tamarisks, growing upon the usual mounds, and encircled by rudimentary dunes. This was followed by extensive alluvial deposits, perfectly horizontal, which three years ago were all under water that came from Jangi-köl, half-a-day's journey up the river. The reason of this tract having dried up was said to be that the Tarim was that year considerably lower and smaller in volume than usual, the consequence

of which was that the overflow area was then at a higher level than the river itself. The natural canal from Jangi-köl still remained, plainly and distinctly outlined. During the rest of the day's march the ground everywhere bore indications of having formerly been a lake-basin, being littered all over with mollusc-shells as well as containing an abundance of old and dead kamisch stubble. We observed the first three dead poplars on our left. Here was also a thin sprinkling of dead tamarisks, some with, others without, mounds, and indeed the country was nowhere entirely without them; but it was only rarely that we observed a living bush. Thus the scenery grew decidedly desolate, though of sand there was indeed little; the few solitary dunes lay generally in semicircles on the leeward side of the mounds, or were gathered in the old river-beds and depressions. But a little reflection is sufficient to convince one, that it cannot very well be otherwise, for the former



Fig. 381. CAMELS DRAGGING OUR CANOES OVERLAND FROM THE TARIM TO JANGI-JER.

lake, to the presence of which the kamisch and shells bear witness, prevented the formation of sand-dunes. And Numet Bek of Abdal, the chief of the district, also told me explicitly, that ninety years ago there was a lake here. A shallow lake-basin such as this can indeed be overwhelmed by migratory dunes, but even where the sand of the Desert of Lop lies thickest it is incomparably lower than in the Desert of Tschertschen; and in former times Lop-nor itself prevented the sand from extending towards the south-west.

As we advanced dead poplars became more numerous; they still retain some quite thin branches and twigs, from which it may be inferred that it is not so very long since they were deserted by the water. This old forest is densest on both sides of an ancient river-bed, which is still remarkably distinct, and stretches in both directions as far as one can see; this must in its time have had precisely

the same appearance as the Tarim presents now — the same breadth, the same depth, the same distinctly marked erosion terraces, and moreover it flowed parallel with the existing river. The only difference between the two is therefore this, that whereas the old river-bed was shaded by poplars, the existing stream has bare banks. And yet this forest was nothing like so thick and vigorously grown as the primitive forest is in many parts on the banks of the Tarim. It never had time to attain to full maturity, in this resembling the forest beside the Ettek-tarim; the water ceased to visit the roots of its trees before these reached a good middle age. There is, further, a great difference between this dead forest and the dead forest we subsequently found along the course of the Kuruk-darja; the latter is as brittle as glass, and all that remains of it *in situ* are the trunks and an occasional branch, though there are numerous trees lying on the ground. Beside the old river to the north of the Tarim the case is however different: there all the trees are still standing on their own roots and the minutest twigs are still preserved; and, besides, the timber is of such a character that it is plain no great space of time can have elapsed since the sap coursed up it, giving vitality to the tree above. In other words, the timber is quite good enough to use for building material; and it is indeed used as such for constructing new huts at Jurt-tschapghan. Hence there cannot exist the smallest ground for doubting, that the Kuruk-darja is older than the dried-up river-bed I am now discussing, though it again is older than the existing Tarim. Further, it is easy to understand that the dried-up river-bed must have been the chief artery of the Tarim system during a longer period than the existing Tarim-bed has been. And the difference between their ages is very considerable, for it may be confidently taken for granted, that a long time must elapse before forest will grow up beside the lower Tarim as vigorous as is that which has been condemned to shrivel and die beside the old river-bed, when the stream deserted it to take yet another step onwards in its migration to the south.

Old kamisch stubble is likewise extraordinarily plentiful on both sides of this old river-bed; in fact it occurs everywhere where the ground is not already occupied by dunes about 2 m. in height. These last are however now increasing in numbers. In this respect too we may confidently assert, that the conditions of this former course of the river were the same as those which obtain in the case of the existing stream. Extensive marshes and marginal lakes, the results of the river's periodical overflows, have given origin to dense fields of kamisch, precisely as we see to-day in, for example, the lakes of Abdal. A little further on the sand becomes practically continuous, except for the mounds of the dead tamarisks, though the dunes are seldom more than 4 m. in altitude. At intervals furrows or trenches in the clay sub-soil, called *jardangs*, traced between long elevations or ridges, crop up amongst the dunes, and make travelling difficult, owing to the fact that our route led up and down across them. For they all run towards the south-west, and thus betray the source of their origin — the predominant wind. Finally, after threading our way through a veritable forest of *kötäk*, or dead tree trunks, embraced and enmeshed by the dunes, we were surprised by the sight of a wide lacustrine region, with tall yellow kamisch, stretching east and west as far as we were able to see, though bordered on the north by dunes and tamarisk-mounds. The sheets of water are for the most part hidden

amongst the kamisch, though there is a belt of open water next the shore. But the strip of shore itself, down to which the dunes generally advance, is very treacherous and soft; the only places in which you can find firm ground under your feet down to the water-line are where the dunes jut out like capes and peninsulas into the lake. This ring of open water all round the shore proves that the lake was that year considerably larger than it had been previously; and this inference was confirmed by our guides. Had it not been so, the reeds would have established themselves there also. Here there were living tamarisks sticking up above the reeds and growing as usual upon their high conical pedestals. The fauna of the locality was represented by swans, and one or two other species of *Nataiores*, by crows, hares, and lizards; while the tracks of wild-boar were more numerous than in any other part of the Tarim system that I have visited. Foxes, wild-duck, and wild-geese also occur, though we did not at this time see any. Fish are especially plentiful, and the reason the natives do not avail themselves of this store is said to be the newness of the waterway (6 years), it being scarcely as yet known to them; besides, there exists no reason why they should yet desert their present fishing-quarters in the Kara-koschun.

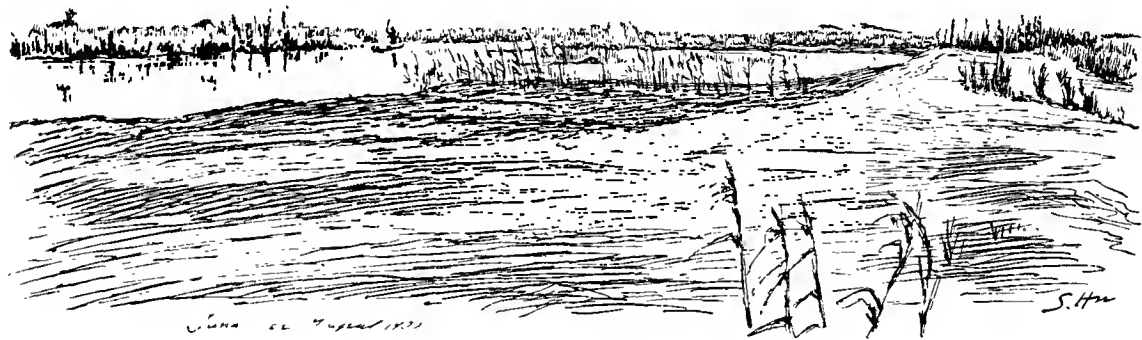


Fig. 382. THE LAKE AT JANGI-JER.

The place in which we encamped is called Jangi-jer, or the New Place. Here, notwithstanding the name, it is evident there must at some former time have been water, judging from the belt of forest along the southern shore. Yet the intervening arid period had been sufficiently long to cause the belt of forest to die out — a period which must unquestionably have been longer than the period which has elapsed since the Ettek-tarim was abandoned; for, as we ascertained, the forest there has not yet died out. Thus the Schirge-tschapghan branch is a stadium in the Tarim's migration to the south. The water has, it is true, returned, but it has not been able to rekindle afresh the spark of life in the slumbering forest; but it will, if time only admits of it, afford nourishment to the sprouting scions of a fresh forest.

Pitching our camp (No. XXVII) on the shore of the lake where there were several *partscha-köl*, or isolated pools, amongst the dunes, we at once got our canoes afloat. A couple of boatmen stepped in and went off to reconnoitre; but they returned with the information, that they had not succeeded in discovering the current, in fact it evidently did not touch that shallow sheet of water. Climbing to the top of a dune near the camp, I made out the water extending N. 40° E., and in that direction shut in by dunes and tamarisk-mounds. The real direction must however be

more easterly, for this sheet of water, which begins at Schirge-tschapghan, terminates in the Kara-koschun, a day's journey below Kum-tschapghan, according to the natives, at a point due north of the old fishing-village of Kara-koschun (Prschevalskij's Kara-kurtschin).

In the evening the wind blew hard from the south-west, though it soon veered round to the west, and afterwards in an instant shot round to the north-east, where it stuck. In the afternoon it began to drizzle, and early next morning it rained for a couple of hours so smartly that we, lying out in the open as we were, got rather wet. All next day the weather continued cool and raw, a thing scarcely to be expected at that season of the year. Before the morning was over we were in the middle of a regular kara-buran, smothered under clouds of dust and drift-sand. But so long as we kept in the shelter of the reeds it did us no harm; but when we attempted to manœuvre our heavily laden canoes out in the opener parts of the lakes, our position became anything but enviable.

Owing to the tolerably large open spaces, we at first made excellent progress, although the lake-shores were everywhere hidden from us by impenetrable thickets of reeds and sedge, and it was only by the glimpses we got every now and again of the tamarisk-mounds and dead poplars that we knew where the shore was at all. Our course turned towards every point of the compass, though on the whole we travelled west. At its maximum this lake was one meter deep, generally only  $\frac{3}{4}$  m., and almost everywhere its bottom consisted of bare sand. To the north we saw two or three open sheets of water surrounded by tamarisks. In the narrow, shallow parts of the lake the current was distinctly perceptible. But this first lake soon contracted to an arm (*tarim*) or sound of 4 m. in breadth, with a velocity of 0.42 m. in the second, and successive depths of 1.47, 2.80, 2.60, 2.10, and 2.40 m. The sound was bordered by firm banks of clay, with numerous mounds of living or dead tamarisks, and on the southern side dead poplar forest. But not all the water of the Schirge-tschapghan branch came along this route; some of it is said to find its way by other channels to north and south of it, and this information appeared to be confirmed by the narrow winding ribbons of water and the vast beds of kamisch.

After that we emerged upon broad expanses, but soon plunged again into a perfect labyrinth, where even our guides did not know the way. In fact it was an absolute maze of small basins, open sheets of water, tamarisk-mounds sticking up here and there, dense impenetrable reeds, towering above us like house-walls — thickets, promontories, bays, and sedimentary islands — all flung down pell-mell together with no directing current by which to find one's way through the confusion. We spent three hours trying, almost at haphazard, to get out of that disagreeable *jangal* («thicket-forest»); nor was it much use to climb to the top of the highest tamarisk-mounds with the idea of looking around us, for the water was everywhere hidden by the tall, thick reeds, and at some distance away there was nothing at all to be seen owing to the dense dust-haze in which the entire landscape was enveloped. Three times we dragged our canoes across little tongues of land, and several times set fire to the reeds, that we might get some glimpse of where we were more immediately going to; but after the rain the reeds would not burn, and we only got smothered with soot. In one place we found the reeds had been burned by the

people of Abdal during the winter, to make room for the young kamisch shoots to grow up in the spring. These sort of fire-clearings are called here *öjtäng*, i. e. *örtäng*, the same word as Prschevalskij's *Ujtun*. Sometimes we caught to the north glimpses of dunes rising 3 to 4 m. in height, and just peeping over the kamisch.



Fig. 383. DRAGGING THE CANOES ACROSS A NARROW TONGUE OF LAND.

At last however we once more came out into running water, an actual current in fact, and our men had to paddle for all they were worth to make headway against the powerful suction. The velocity of the current was sometimes as much as 2.32 m. in the second; this was occasioned in part by the Schirge-tschapghan arm being shorter than the Tarim, in part it was owing to the fall being concentrated in the sections of connecting current, and in part it was due to the acceleration of the current, caused by evaporation and absorption in the lower lakes, a loss which has to be continually made good from above. Here again it was reported, that there are other currents or arms to both north and south. Our arm turned first north, then west. For the most part it was contained between well-marked banks, plentifully supplied with alluvia, and having at intervals tamarisk-mounds or young tamarisks growing straight out of the level ground without the usual mounds. Sometimes however the actual banks on the one side or the other were masked by the reeds. Sometimes too we saw the sparse *kötäk* of poplars looming faintly through the haze. It was plain that the water had here sought out an older and larger

channel, for the relatively insignificant volume which was then flowing through it would never have been able to excavate the bed in the pronounced way it was excavated, not even if we suppose the current to be at times very materially swollen. The *kamisch* was in some places as dense and luxuriantly developed as in the marsh of the Kara-koschun. A capable hunter who was with me, and knew that region well, told me that the reeds were quite as big and extensive three years before, when the people of Abdal first made the discovery that water had returned through this arm. It is true, the *bek* had declared, that this branch was six years old; but it is very probable that the water had gradually spread thus far from the lakes beside Schirge-tschapghan, and that this process had taken place earlier without being observed by the natives. To obtain a comprehensive survey of that intricate net of waterways in one canoe-excursion was impossible; for one thing, the reeds prevented us from seeing anything either to right or to left, and all that I was able to record on my map was the sinuous line of our actual course. In what way the different lakes and marshes are arranged with regard to it I am really unable to say. After passing pretty extensive sheets of open water on both north and south, we encamped on soil that was everywhere moist, showing that quite recently the water-level had been a good deal higher, at least half a meter higher than it was then; but we managed to get a dry bed by heaping up armfuls of *kamisch*. Meanwhile the storm continued to howl around us, so that the foam was whipped from the crests of the waves. Along the southern side of the route we had followed during the day there was a rather narrow belt of low dunes, but beyond this there is reported to be, right away to the Tarim, nothing but *sägis* or clay soil without sand. Along the north side there is on the contrary quite a respectable zone of sand, though how far it stretches towards the north on this meridian I do not know — at any rate it reaches a good bit beyond the latitude of the Avullu-köl. Hence the difference in height and size between the dunes on the north and those on the south is perfectly self-evident. There was clearly a time when there was no sand at all on the south, the river being the extreme limit of its southward extension. Such sand as did by chance lie there has had time to get blown away, and has not been replaced by fresh sand from the windward, where however it has become heaped up as it has advanced. But when the region ceased to be watered, the northern dunes were able to resume their migration, and then it was that the strip of sand was formed along the south side of the river. But since then the connection between the two zones of sand has been once more severed.

The storm continued all night. To the north the sky was grey and heavy with drift-sand, though somewhat lighter over the lacustrine region. On the 16th we



Fig. 384. IN THE REEDS.

pursued our journey, travelling through a chain of long, narrow lakes. Here the route was much easier to find, owing to the shallow sedimentary deposits which border the stream; from these we perceived that the supply of water from higher up was diminishing. The low sand on the south is here planted with scrub, while on the north the dunes are higher and for the greater part destitute of vegetation. Gradually the lake contracted, and we glided into an actual, sharply defined river, where the entire current was concentrated into one channel. We still continued to travel north-west. The banks are clothed with reeds or studded at intervals with tamarisk-mounds, still preserving their integrity. On the north the dunes generally descend precipitously into the water; it is palpable that the sandy desert is here pressing hardly upon this waterway, especially in places where it turns towards the north-west, and thus is directly exposed to the prevailing wind, besides coming into intimate conflict with the dunes that the wind drives forward. At intervals there are small marginal lagoons, or apophyses, from the main river, wedged in amongst the dunes and mounds, and without running water.



Fig. 385. CAMP XXVIII. VIEW TOWARDS THE SE. ACROSS A LITTLE LAKE FORMED BY THE TOKUS-TARIM OR SCHIRGE-TSCHAPGHAN BRANCH.

Choosing a narrow and suitable place, we measured the river in the usual way, by stretching across it a rope marked off in sections of equal length. The results were — breadth, 16.6 m.; mean depth, 1.270 m.; mean velocity, 0.4464 m. in the second; and volume, 9.41 cub.m. in the second. Thus the volume here was only one-third of that which a few days before we had measured at Kum-tschapghan, and only one-ninth of what we had found in the Tarim at Jurt-tschapghan.\* These 9.41 cub.m. were derived partly from the Tarim *viâ* Tschivilik-köl, and partly from the Kontsche-darja, the Ilek, and the eastern chain of lakes. I resolved therefore to spend the next few days in finding out where it did come from, by paddling up



Fig. 386. VEGETATION ON THE SOUTHERN BANK; — DUNES ON THE NORTHERN BANK.

\* See vol. II.



against its stream, for the waterways are so intricate that it is only by a properly planned boat-excursion that one can understand them. I felt justified in assuming on *a priori* grounds, that the volume decreases rapidly as the stream descends, not only in consequence of the numerous marshes, lagoons, and lakes which it fills on the way, but also because, this eastern waterway having lain for so long a time dry, large quantities of water would naturally be absorbed in the ground. The bed was as yet barely moistened through; at all events it was less moist than the corresponding parts of the Tarim.

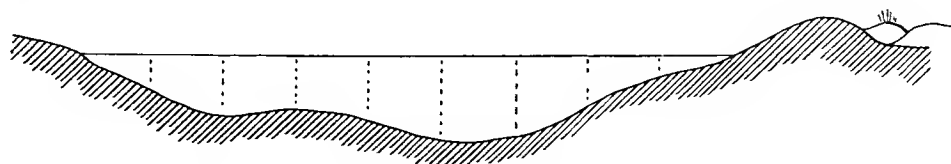


Fig. 387. Right. 0.88 1.51 1.45 1.62 2.16 2.06 1.25 0.50 = depth. Left.  
 41 50 61 62 53 49 41 30 } velocity.  
 24 47 54 55 54 52 41 22 }  
 40 46 53 50 51 40 }

Breadth = 16.6 m. The Tokus-tarim (Schirge-tschapghan branch); April 16. Scale 1:200.

In this locality we did not observe a single fresh young poplar, although old and dead trees are by no means rare. Hence it cannot be attributed to the nature of the ground, that poplar woods have not yet re-established themselves here. Wherever the water goes, there we find the forest following closely after it; and once the new waterway settles down for a permanent stay, the forest will shoot up beside it as readily as it has done beside the Ettek-tarim and the Tschong-tarim below Arghan.

At one point our stream widens out to a little lake. At the point of expansion the river had a breadth of only 10.0 m. and a velocity at the surface of 0.9 m. in the second. After that we paddled across a long, narrow lake pointing towards the west-north-west, plentifully dotted over with patches of reeds, like islands and holms. On the other hand the shores were almost everywhere free from reeds, and distinctly visible all round, especially on the north, where there was a backing of light yellow dune-walls. The reeds here are both less luxuriant and less dense than at Jangi-jer. The entrance to the river at the far end of this lake is marked by a veritable delta of sedimentary deposits and sand-banks. The river, which is now broad, and full of sand-banks, flows towards the north-north-west, thus exposing its left bank to the attacks of both the wind and the advancing dunes. It is to these two agencies that the abundance of sand-banks is due. Under normal circumstances sand-banks ought not to occur in a stream that traverses a long series of small lakes, in which it has an opportunity to deposit such materials as it carries in suspension. But here the encroaching dunes supply material for the river's erosive power to work upon for the formation of alluvial deposits and sand-banks, both in the actual channel and in the delta that encroaches upon the adjacent lake. Tamarisks are very numerous upon the west or right bank, some living, some dead, but all alike standing upon mounds. Sometimes the river splits into two arms for a short distance. It was here we discovered the first traces of human beings having come from the west, in poles set up in suitable places for supporting

fishing-nets. We learned subsequently, that the fishermen of Schirge-tschapghan extend their excursions thus far, but no farther, towards the east.

After that, short reaches of the river alternated with small lakes until we reached a district which my guides knew under the name of Tokus-tarim, or the Nine Streams, a very appropriate name, for the river does divide there into several arms, though, as we have seen, they soon reunite and form one again. Some of these arms are separated by firm ground, others by belts of kamisch only; they all issue out of a relative large open lake possessing no name. Except for a few tiny clumps of kamisch along the shore, this lake is destitute of vegetation, possibly as a consequence of relatively deep water in the middle. It was however impossible to sound it, churned into waves as it was by the persistent storm. In fact, we had to keep our canoes close in under the eastern shore to prevent them from foundering. This took us to the north, where we obtained shelter on the leeward side of the barren dunes, nearly 4 m. high. A very few tamarisks are growing on the shore, but we saw that they soon come to an end on the east, where lies the Desert of Lop. The depth along the shore nowhere exceeded 1.2 m. On the west side of the lake there are tamarisk-mounds standing amongst the dunes. This lake fills an extensive depression of the desert, and its future is not difficult to foresee. The whole of its eastern side is exposed to the irresistible invasion of the sand, and is being pushed westwards by its attacks. Against the attacks of the waves this shore is however protected, although they play havoc with the opposite or western shore. This shore too, in consequence of the abrasion and of the dunes' desertion of it, likewise travels west, though at a relatively slower rate, and in a relatively less complete degree; what small amount of vegetation still survives on that side is at any rate insufficient to arrest it. The result is, that the lake is contracting, and eventually it must be entirely overwhelmed and blotted out by the sand.

Upon reaching the northern end of the lake, we turned first towards the west, then towards the south-west, traversing another long, narrow sheet of water and then entered yet another short river-reach, on the right bank of which we pitched our camp (No. XXIX). Here we found fresh traces of domestic animals, of camp-fires, and offal of fish; besides an abundance of dead poplar wood.

On 17th April after crossing over a small lake, we entered a riverarm which had a maximum depth of 1.85 m. The banks are thickly occupied with low dunes, tamarisk-mounds, dead and living kamisch, and dead poplar forest, all intermingled without any order, but pointing to two periods in which the river visited this locality, with an intervening period in which it failed to do so. Living tamarisks are by no means rare, and they are so big and well grown that they have evidently been able to survive the intervening waterless period, the roots having of course penetrated downwards to the underlying ground-water. The shore is in places white with lacustrine shells (molluscs etc.), they too a survival of the former overflow period.

Thereupon we emerged into a large lake, which however proved to be a veritable rat-trap to get out of again. First we paddled a pretty long way towards the south-west. until, finding we had only got into a *cul-de-sac* (*sollak-su*), we were

forced to go all the way back again. Next we tried keeping close to the east shore and steering to the north-north-west. The shore was extremely capricious in outline, being broken by an immense number of capes, bays, and islands, and plentifully studded with high conical mounds, from which the tamarisks had entirely disappeared, so that the mounds themselves must be of great age. Vainly we sought a way out, or even for some current that might serve to guide us in the right direction. At last, putting into a creek on the north, we climbed a high mound on the shore so as to get a survey of this exasperating sheet of water. Eastwards we saw what appeared to be a lake entirely detached and surrounded by lofty dunes, with any amount of dead poplar forest amongst them. Fortunately we also discovered, a little distance away, a flock of sheep, and the shepherd in charge of it was induced to show us the way. By pure chance the creek into which we had entered was precisely the one we wanted, and so we continued along it towards the north. The vegetation on both sides of the stream is all dead and withered, except for some reeds. The western or right bank of this creek, which is both long and broad, is shown in vertical section in the accompanying fig. 388. It possesses

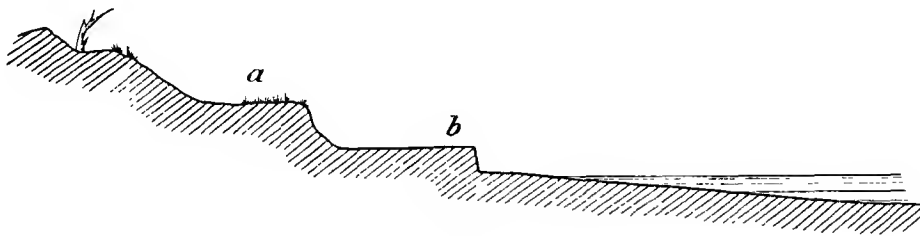


Fig. 388.

a distinct and beautiful shore-line (*a*) still surviving from the former irrigation period. It was  $1\frac{1}{2}$  to 2 m. above the then existing level, and is distinguished not only by its well-defined form, but also by the dead kamisch stubble which accompanies it. The section shows also the barren alluvial terrace (*b*), with its sharp-cut eroded face, created by the last high-flood, and rising 70 cm. above the level of the stream. During the former irrigation period the water-level was thus one meter higher than it is now; nor is this surprising, for there can be no doubt that at that time the whole of the discharge of the Tarim system travelled this way. The former presence of a powerful river is indicated by the form of the creek (see fig. 389). The

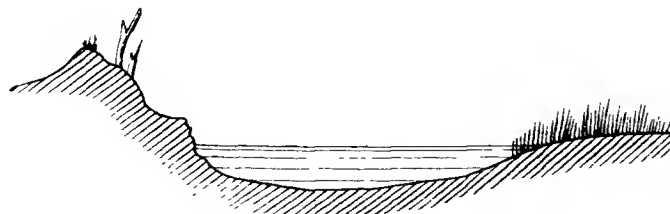


Fig. 389.

upper shore-line is visible only on the west side of the stream, probably because it has been not only attacked by erosion, but likewise exposed to the buffeting of the waves, driven against it by the east wind.

Eventually this arm contracts and describes a gigantic curve, having on the left (its right) dead poplars and tamarisk-mounds, and on the right (its left) living tamarisks and kamisch, and after that dense reeds on both sides. The erosion-terraces are clearly defined, and at least one meter high. Here too there are numerous indications of a former water-level. When the entire volume of the Tarim formerly travelled this way, the banks were heavily wooded, so that they exhibited very different characteristics from the bare and desolate region through which the new Tarim flows to the south.



Fig. 390.

The shepherd led us to a hut, the owner of which then accompanied us in his canoe; and fortunately for us, for without a sure guide we should have found it absolutely impossible to make our way through the intricate labyrinth of waterways which lay ahead of us. To begin with, leaving the broad river-bed in which we had hitherto travelled, we turned into a small side-channel hidden among the reeds. The former is said to come from a lake a little higher up, which during the last few years has become entirely overgrown with reeds and sedge, so that it would have been utterly impossible to keep to it any longer. The little side-channel up which we penetrated was only 0.7 m. broad and rather deeply trenched. Its banks were smothered in reeds of extraordinary density. The velocity was at first 0.42 m. in the second, but afterwards it quickened. Every now and again the channel expands

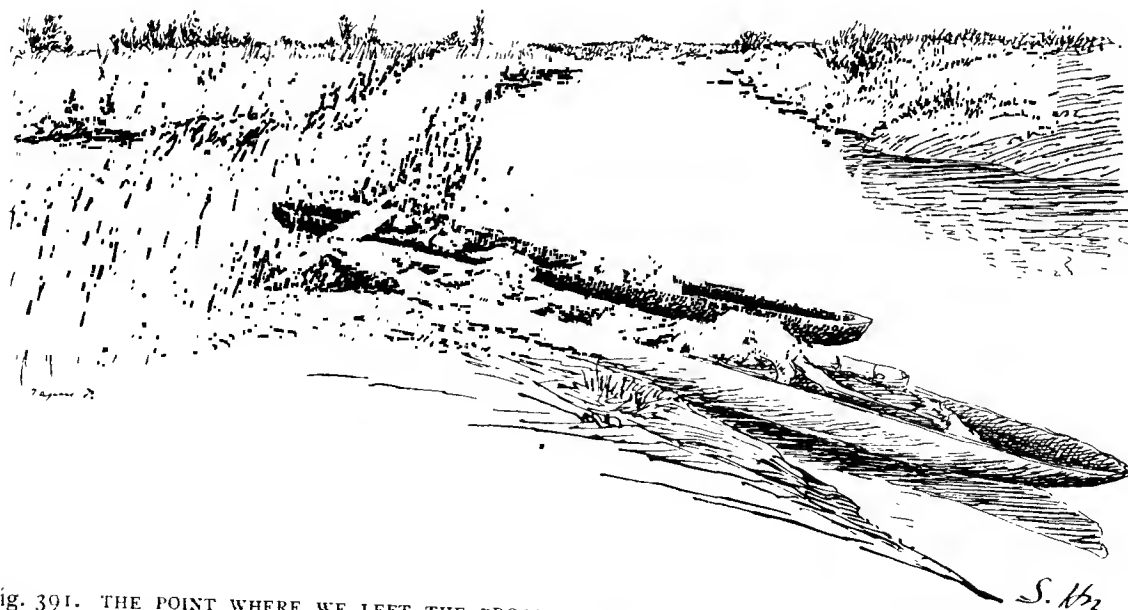


Fig. 391. THE POINT WHERE WE LEFT THE BROAD RIVER-BED AND ENTERED THE SMALL SIDE-CHANNEL.

into little dark, deep basins. It also possesses a small cataract, 0.55 m. in height, where the water, bluish green and as bright as crystal, plunges down the threshold with a good deal of splutter and froth. We dragged the canoes past it through the reeds. Then follow a series of miniature lakes, with a thousand windings in and out amongst the islets, bays, and tamarisk-mounds, the whole buried in dense reed-brakes, until we came to another little cataract of about 0.57 m. height. Thus within a very short space we had ascended 1.12 m. In the corresponding sections of the existing Tarim there are no such cataracts, but the fall is distributed generally over the entire course of the river, the only lakes it has being some small ones near Kara-buran. From the freshwater lines, which in the largest lake we crossed during the day were distinctly visible at 0.175 m. above the then existing level, it is plain that the volume in this more northerly waterway was considerably larger immediately after the melting of the ice. Thus the level was at this season dropping day by day in the same way as it does in the Tarim.

Once more we plunged into a labyrinth of *tschapghans* so narrow that there was seldom room for more than one canoe at a time to paddle up them, hardly ever for two abreast. These narrow channels are cut through sedge (*jäkän*), packed extraordinarily close together, and backed by tall kamisch. Still we did in places cross open expanses of water, generally in the deepest parts of the basins. In one of these larger expanses we obtained a sounding of 4.01 m., and in a smaller expanse a sounding of 2.90 m. Properly speaking, what we were traversing was one single large lake, called Atta Bajdeni-köl, which in the course of time has become practically grown up with reeds and sedge. These last effectually prevented us from obtaining any idea of the lie of the shores, as well as from mapping them. It was only very rarely that we caught glimpses of firm land through the reeds, but that may just as readily have been islands. The lake of Öjen-aldi-köl, the Lake in front of the House, is more open, and gave depths of 3.70, 3.00, 4.22, 3.00, and 2.50 meters; so that the soundings we obtained in this lake were but little less than those we obtained in the Kara-koschun (see vol. II).

We encamped at the village of Jäkän-öj, a place of a few huts, with 4 ujlik of about 20 persons in all, though 19 of them were at that moment at Tscharklik, engaged in agricultural work. In the way of live-stock the village owned 100 to 150 sheep, 15 cows, 14 asses, and 6 horses, the last too being also absent at Tscharklik. These four families were formerly settled at Tschigelik-uj, and remembered quite well my visit there in 1896. But they removed from that place in the year following, and founded Jäkän-öj. They are however not settled permanently,



Fig. 392. THE FIRST CATARACT IN THE CHANNEL.

but spend only 3 months of the year there, 4 at Tschigelik-uj, and 5 months at Schirge-tschapghan. On the present occasion they had arrived at Jäkän-öj in the beginning of March, just at the time when the ice was breaking up. During their stay there they are occupied in fishing. But as the winter-grazing at Schirge-tschapghan is better than at other places, as well as more abundant, they usually go there for the winter. These people told me that these lakes and the waterway I have described were formed seven years ago; previous to that the country was *tschöl*, or „desert“, except that it possessed a certain number of living tamarisks. After the water came, the reeds and sedge shot up, as well as a score or so of quite young poplars (2 to 5 years old), which had established themselves near the huts. Close by were also some old dead poplars, mementos of the former irrigation period. One old poplar which had been on the point of dying had just managed at the last moment to shoot out new twigs when the fresh water came. During the four years these people had visited the locality they did not remember to have noticed either any increase or any decrease in the volume of the water; yet for reasons which I



Fig. 393. WATER-ARM NEAR JAKAN-OJ.

shall quote later on there must have been an increase. The limits of the local geography beyond this new waterway extended north as far as Kum-tscheke and eastwards as far as Tokus-tarim. Viewed from their huts this lake-complex bore the appearance of a single stagnant marsh, swarming with gnats and mosquitoes, though that year they were stated to be less numerous than usual owing to the severity of the previous winter. Here too there had been snow, and the rainfall had been more copious than usual.

On 18th April, followed by quite an escort of canoes, we directed our course towards the south-west, across another chain of lakes. The first of these is called Toghraklik-köl, and is 4.0 and 4.5 m. deep; the second Karaunelik-köl, with depths of 2.50, 3.65, and 4.17 m. On our right, that is to the north, and quite close to us, was a patch of tolerably high, barren sand, which shone yellow above the luxuriant paludal vegetation. Dead poplars and living tamarisks were both numerous. In summer certain portions of the lake are said to be cut off from the rest, though without turning salt. After that old living poplars made their appearance on both sides,

but especially to the south, as well as numerous old trunks, on which fresh branches were sprouting. Thus this district of Schirge-tschapghan is the only one in which old, and at the same time lusty, poplars occur. South of this point, and right away to the extreme eastern end of the Kara-koschun, these trees are entirely absent; but east of the same point, alongside the waterway we had just traversed, there are old dead tree-trunks. From this the inference is perfectly obvious, that Schirge-tschapghan marks the southernmost point common to both river-systems, and the only point which during both overflow periods was uninterruptedly irrigated, without its forest being destroyed by an intermediate period of aridity. On the southern shore are some huts embowered in a poplar grove, and inhabited by three families. The depth here amounted to 4.25 and 4.32 m.

These lakes, and especially Karaunelik-köl, perform the peculiar function of serving as water-partings or watersheds, for within them a bifurcation takes place. The water which comes to them from the Kara-köl through the Ilek of Kumtscheke afterwards divides and proceeds in two different directions, some to the east, along the waterways we had just traversed, and the rest to the Tarim. In both cases the terminal basin is the same, namely the Kara-koschun. At the time of our expedition the lake lay 55 to 60 cm. higher than the level of the Tarim, so that there were necessarily cataracts in both directions, though the cataract in the western system is not so high as that in the eastern.

The people of Jäkän-öj described the Karaunelik-köl as an *ajraldighan-jer*, or »place of division». They said that the water first entered this basin seven years before, and in the very first year of its arrival divided into two branches, one going to the east, the other to the west.

At that time the only vegetation consisted of tamarisks; otherwise the country was *tschöl*, or »desert». But the vegetation gradually, and during the first three years the volume of the water increased appreciably. There can be no doubt that, previous to these seven years, a very long time must have been spent in filling the Kara-köl and its sister lakes, and that they were able to send the water on farther to the south. The other lakes which we saw beside these lakes were, like those of Jäkän-öj, built four years before. The natives were unable to tell me where the water of the eastern division went to, for in that direction they have not carried their reconnaissances particularly far.

From Karaunelik-köl we had the current therefore with us, and it took us through a number of rather narrow passages, in fact a maze of mounds, sand, and kamisch. In the Kultuk-köli the depth amounted to 4.60 m. Gradually we emerged into a distinctly marked channel, a *kok-ala*, deeply excavated, as well as fenced in by containing banks 1.67 m. high, and crowned with tall tamarisk-mounds (fig. 394). Then, descending a little cataract, we found ourselves in a small expansion of the river, surrounded by rejuvenated toghrak forest. On the right we perceived some uninhabited huts. Shortly afterwards the canal enters the Tarim, its bright, limpid water being instantly swallowed up and lost in the thick turbid current of the river. Continuing down this last, we stopped just before reaching the huts of Schirge-tschap-

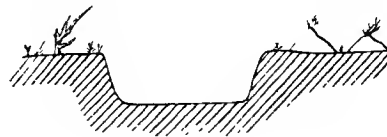


Fig. 394. DEEPLY EXCAVATED  
BED OF »KOK-ALA».



Fig. 395. THE KOK-ALA BETWEEN KULTUK-KOLI AND SCHIRGE-TSCHAPGHAN.

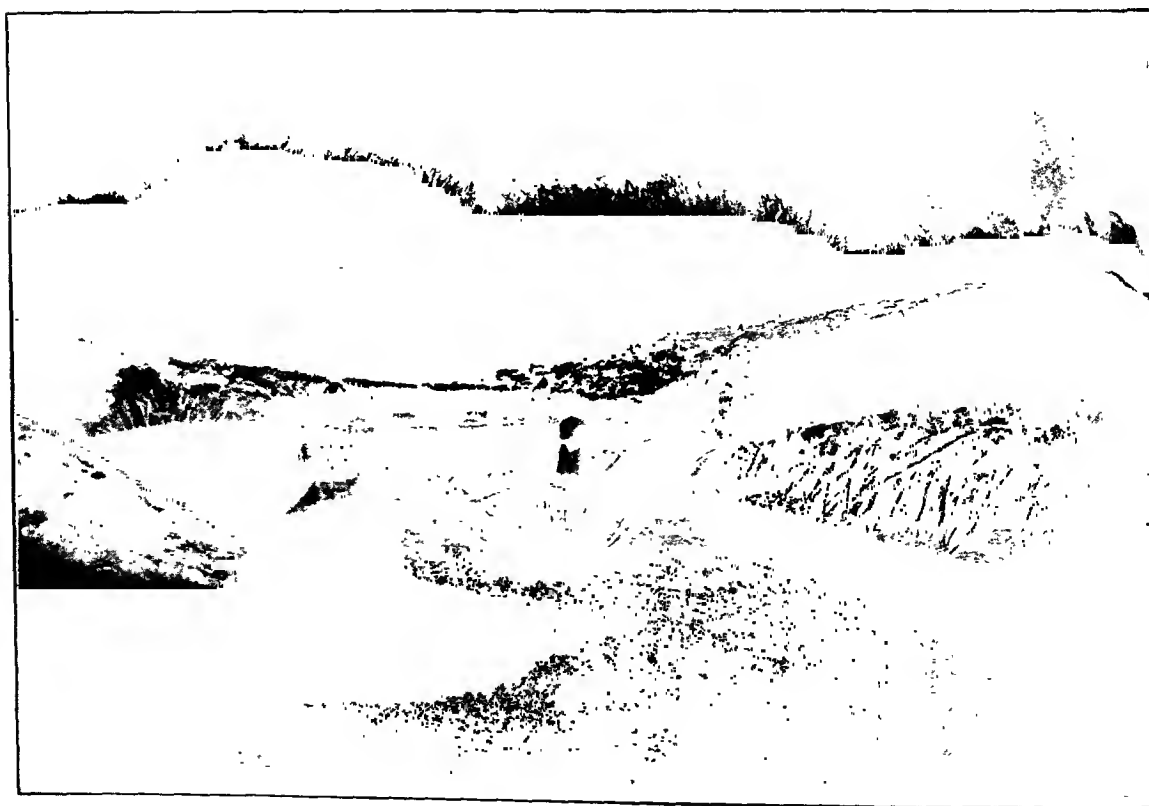


Fig. 396. THE SAME CHANNEL.



ghan, and encamped on the left bank. The river, being here unusually straight, and its banks well wooded with old and lofty forest-trees, though some are gnarled, presented a magnificent piece of scenery.

From this camp we made an excursion to the lower canal that issues from the Karaunelik-köl. It is spanned by two bridges, and from the lower of these it was quite evident that the water had risen since 1896, for the bridge in question, which was also in existence in the year named, was on this occasion submerged to the extent of some centimeters, so that canoes would float over the top of it. The other bridge has been prudently thrown across at a much higher level and is out of danger; in fact, we paddled under it quite comfortably. This canal arm is likewise deeply excavated, and yet at its mouth the adjacent banks were only 0.50 to 1 m. above the surface of the water. In 1896 there was a small waterfall at the embouchure of the lower arm: but since that date it has ascended to its existing position, and dwindled to a cataract.



Fig. 397. THE BROAD, OPEN PART OF THE LOWER KOK-ALA OF SCHIRGE-TSCHAPGHAN; VIEW TOWARDS THE NE. FROM THE RIGHT BANK.

Above the lower bridge the canal expands, until it resembles an old, but imposing, river-bed, or an oblong lake. Possibly at some time or other the Tarim in the many vicissitudes of its history has once flowed along this channel. Its banks too are reminiscent of an old river; for, while the left (eastern) bank is convex and low, and planted with a plentiful toghrak forest, the opposite or right bank is concave and vertical, rising 2 m. above the level of the water. It is amongst the old poplars of the right bank that the huts of Schirge-tschapghan are situated; higher up

are numbers of tamarisk-mounds. The actual bed is 70 to 80 m. broad, the breadth being pretty uniform throughout. A relief of this character could only have been brought about by a river possessed of considerable erosive energy. Assuming then that the Tarim did once flow this way, we may imagine the following changes to have occurred in its river-bed. At some epoch in its existence the river, in conjunction with the Kontsche-darja, flowed through the eastern waterway approximately along the line of the existing Ilek, the Kara-köl, and the other lakes, then through the Sadak-köl and Karaunelik-köl, through the broad channel I have spoken of at Schirge-tschapghan, and then eastwards, following the bed which we crossed on our way from Jurt-tschapghan to Jangi-jer, and beside which we found an abundance of dead toghraks. Had it flowed through the existing bed that goes *viâ* Tschigelik-uj, we should now find there old forest, similar to that at Schirge-tschapghan. After the full stream was diverted into the western Tarim that goes *viâ* Arghan, this eastern bed dried up. In 1896 I was a witness of how it had again come into activity; and four years later I saw how it is growing bigger year by year, while the volume of the Tarim diminishes in the same proportion.

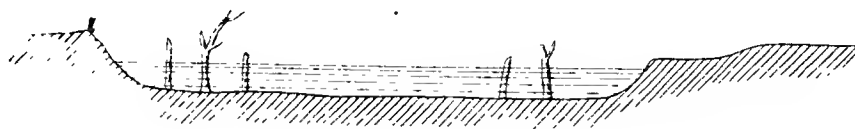


Fig. 398. DEAD TOGHRAKS IN THE BED OF THE LOWER KOK-ALA.

The broad channel is joined at its northern end by a canal-arm which issues from the lakes that are completely choked with kamisch and sedge. This arm is 5 to 8 m. broad, and very winding, and has high eroded banks, a swift current, and beautifully limpid water (full of fish), which really comes from the Karaunelik-köl. The lower canal had beside the lower bridge the following dimensions: . . . . .th, 6.3 m.; mean depth, 2.115 m.; mean velocity, 0.2033 m.; and volume, . . . . . the second. The vertical section of the upper arm near its embouc

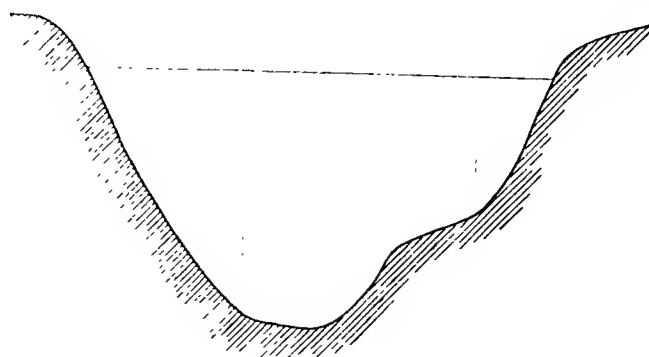


Fig. 399. Left.    2.03    3.22    3.31    2.21    1.87 = depth.    Right.

7	18	20	38	40	} velocity.
4	23	37	32	27	
	22	28	20	24	
		28	0		
		26			

Breadth = 6.3 m. The lower channel at Schirge-tschapghan; April 18th. Scale = 1 : 100.

pretty nearly the same vertical section, but grows smaller in proportion as the depth decreases and the current quickens into a cataract. We measured it just above the cataract, with the following result: — breadth, 5.2 m.; mean depth, 0.623 m.; mean velocity, 0.7525 m.; and volume, 2.44 cub.m. in the second. The left bank was at this spot only 0.48 m. above the water-level. Thus the two canals together contributed to the Tarim a volume of 5.15 cub.m. When I measured their volume on 13th April 1896, it amounted to only 2.67 cub.m. The two measurements admit of being compared together with all the more reason that the date in both cases was approximately the same, there being a difference of only 5 days between them. Thus in four years the volume had doubled, that is to say, the volume of the stream which flows from the Karaunelik-köl into the Tarim. What change, if any, took place in the eastern branch, the Tokus-tarim, during the same four years, it is difficult to say; though I suspect the augmentation has been in its case very much greater. Numet Bek told me, that the water came to Jangi-jer six years previously; the people of Jäkän-öj, that it reached the Karaunelik-köl seven years previously, and then at once diverged to the east. In that case it would seem to have taken a year to reach Jangi-jer; and that is very likely true, for of course it had to fill all the intervening lake-basins on its way down. Of the two Schirge-tschapghan canals the upper one still enjoys uninterrupted communication with the Karaunelik-köl; but

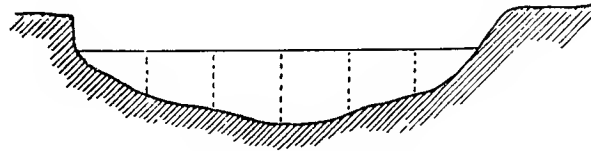


Fig. 400. Left. 0.59 0.75 0.96 0.77 0.67 = depth. Right.  
70 87 95 98 62 } velocity.  
53 80 87 98 60 }

5.2 m. The upper channel at Schirge-tschapghan; April 18th. Scale = 1 : 100.

ers through beds of kamisch and sedge so dense that to dream of  
ough with a canoe was utterly out of the question. In spite of  
the larger volume. The relative figures are as follows:

	1896.	1900.
The upper (western) canal . . . .	0.48 cub.m.	2.44 cub.m.
The lower (eastern) canal . . . .	2.19 »	2.71 »
	2.67 cub.m.	5.15 cub.m.

Hence in 1896 the lower canal was  $4\frac{1}{2}$  times bigger than the upper canal, but in 1900 the difference between the two was but slight, possibly owing to the gradual closing of the embouchure of the former by kamisch, sedge, and decaying vegetation. If these impediments continue to increase at the same rate, the consequence will be that the whole of the volume will go over into the upper canal; and then, if it too in turn becomes blocked up, the water will make its way into the Tokus-tarim. We cannot however employ the two totals I have noted above for

determining the increase in the eastern waterway during the four years, because we do not know what alterations the Tokus-tarim has undergone in the interval. But in the course of my farther journey northwards I shall have an opportunity to collect more abundant data bearing upon the solution of this problem.

In the afternoon the temperature of the water of the Tarim was  $12^{\circ}.2$  C., and of the water of the upper canal  $13^{\circ}.6$  C., it having been warmed in the sun in the shallow lakes. The latter was transparent to a depth of 2.02 m., but the water of the Tarim down to 0.12 m. only, a proof that the stream in these lowermost reaches carries enormous quantities of sedimentary matter; indeed it has with this succeeded in filling up large portions of the former extensive lake of Kara-buran. After this and its sister-lakes have been completely filled, it will be the turn of the Kara-koschun, unless it has in the meantime, from this and several other causes, altered its situation.

Here we observed on the bank of the Tarim three different water-marks; the top one 0.75 m. above the then existing level of the river, indicating the height when the ice first began to form in December; the middle line, 0.40 m. above the existing level, showing in all probability the maximum level to which the spring freshets (*mus-suji*) rose; and the third line at 0.23 m., indicative probably of a level maintained for a longer period at a later stage of the spring freshets.

The following information with regard to the yearly changes that take place in the river at this point were given me by the inhabitants of Schirge-tschapghan. The water is wont to be especially high at the time the ice forms; but during the winter it drops underneath the ice-sheet, so that this last assumes a concave appearance. After the ice breaks up, in the beginning of March, it is followed by the *mus-suji*, or *ullugh-su* («big water», «high water»), which by the middle of April is falling rapidly, as it was at the time of our visit in 1900. And this subsidence goes on day after day until in the end of July the river reaches its lowest level,  $1\frac{1}{2}$  kulatsch (= 2.6 m.) lower than in April. In the end of August the river begins to rise again, quickening its rate of rise in September, and attaining its maximum in October, so that it is still high in November and the beginning of December, when the ice once more begins to form. At this season a rather interesting occurrence takes place, which, though I had no opportunity of observing it directly myself, nevertheless from the account furnished to me sounds very likely true. In November, after the main mass of the high flood has rolled past, the river drops a little. Then towards the end of the month the *kömul*, or «drift-ice», puts in an appearance and drifts past Tschegelik-uj in enormous quantities. This, being arrested in the first kamisch lakes it comes to, gives rise to a stoppage or damming-back of the water, and so leads to a very appreciable rise at Schirge-tschapghan; and the ascending or retrogressive wave can be readily seen a good distance north of Arghan. This stoppage, which at the same time occasions a retardation of the rate of flow, gives the signal for the formation of the ice, and from that point the freezing advances rapidly upstream. The natives who dwell on the banks of the Tarim are all generally agreed, that the river freezes from below upwards, and that is indeed very probable, for it is easy to imagine that similar stoppages may occur at several suitable places in the bed of the river.



THE LEFT BANK OF THE UGEN-DARJA, NEAR ITS CONFLUENCE.  
In the Foreground a Single Canoe and a «Kosch-kemir» or Double Canoe.



*Ljustr. A. B. Lagrelus & Westphal.*

WOMAN AND CHILDREN OF JURT-TSCHAPGHAN.



I was also told, that, contrary to what happens in the case of several other river-arms which dry up during the summer, the two Schirge-tschapghan canals (*kok-alas*) always carry water. All the same, in the height of the summer they are a good deal lower than they were just then. From this we may conclude, that the Tokus-tarim likewise carries water all the year round. During my former journey I found that the volume of the Kontsche-darja is virtually unchanged: year by year, winter and summer alike, it has the constant volume of 71 cub.m. in the second;\* this is because the Baghrasch-köl serves at once as a water reservoir and as a moderator of the discharge. In the same way, although on a much smaller scale, and with a less pronounced result, the Kara-köl, Sadak-köl, and the whole of the chain of lakes of which they form links, function towards a like end. Once they are filled, it takes an appreciable time to empty them, and so long as they receive a constant supply from the Kontsche-darja they cannot indeed very well be emptied at all. My informants also thought they had observed a diminution in the volume of the Tarim during the last four years, a fact which — and probably with justice — they connected with the increase in the eastern waterway. And the inhabitants of Jurt-tschapghan had observed the same thing, namely that the volume of the Tarim decreases in proportion as the volume of the Tokus-tarim increases. In this connection I will not attempt to decide whether this insignificant change in the hydrographical relations is, as an old fisherman was disposed to believe, the cause of the four wells of the Ettek-tarim having this year ceased for the first time to yield water at their usual depths.

At this time there were two families living at Schirge-tschapghan; and at Karaunelik-köl three families of 18 individuals plus 9 more at that instant at Tscharklik. These three families, together with the four at Jäkän-öj, and one of the families of Schirge-tschapghan, or in all 8 ujlik, usually spend the winter at Jalghus-jigde, a little way down the river; consequently it was at the time of our visit uninhabited. The three families of Karaunelik-köl own a small number of sheep, partly at Boghu-baschi, partly at Jäkän-öj. They had arrived at their huts in the beginning of February, when the ice lay thick on the lakes, and made fishing difficult. They intended to remain one month longer, and then go to Tschegelik-uj, and when the water froze again to Jalghus-jigde. Hence these poor fisher-folk, who here too call themselves Lopliks, lead a semi-nomad existence; and this mode of life has been even more enforced upon them since the Chinese began to urge them to take up agriculture at Tscharklik.

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\* I regard this result as only approximate; for it rests upon measurements of breadth, depth, and surface velocity only. Consequently it is certainly too high.

## CHAPTER XXVIII.

AN EXCURSION UP THE EASTERN WATERWAY OF THE  
TARIM DELTA.

When on 20th April we resumed our journey up the eastern waterway, the hydrographical distribution was as follows: the Tarim had a volume of 101.86 cub.m. in the second, while 16.56 cub. m. flowed out of the Karaunelik-köl, partly going east and partly west; so that the eastern waterway furnished about one-seventh of the volume contributed by the western waterway.



Fig. 401. THE HUTS OF KARAUNELIK.

We now continued with three big canoes, retracing in the beginning the route by which we had come down; but upon reaching the huts of Karaunelik we took another direction, namely towards the north. I already knew the country as far as Kum-tscheke, for I had visited it in 1896; but the changes which had taken place in the interval were so great that I scarcely recognised it again. The Karaunelik-köl is connected by certain narrow passages with the Avullu-köl; in this lake a man, Avul Achun, claimed three years ago the exclusive rights of fishing. Next comes the Tschong-köl, or the Big Lake, which fully justifies its name, for its area is larger than any of the open sheets of water we saw in the Kara-koschun. The Tschong-köl,



which extends a long distance towards the west, is in some way or other connected with the Nias-köl, which I crossed over in 1896. There again we were forced by the »high sea» that was running to hug the eastern shore, off which we obtained depths of 2.5, 3.0, 4.0 and 2.6 m. Huge masses of sand are piled up on the shores of the lake, even on the west side, and one accumulation, lying due east of Taghkum, was especially conspicuous, owing to its being higher than all the rest. To the north the lake becomes lost in a maze of water-channels and fjords, giving the landscape the appearance of an archipelago of sandy islands. The next lake, the Kötäklik-köl, is also of great extent. The water-areas of these lakes were of course much greater than they had been four years previously. Along the shores the following succeeded one another alternately — sand, dead tamarisks on mounds, dead toghraks, living kamisch, and sedge. Vegetation is spreading, being in general more abundant than it was in 1896; on that occasion these lakes had a much more desolate appearance. In the bottom of the lake, which consists of nothing but sand, we observed drift-wood sticking here and there; and out in the middle was a gigantic toghrak-trunk lying like an abandoned wreck. The maximum depth amounted

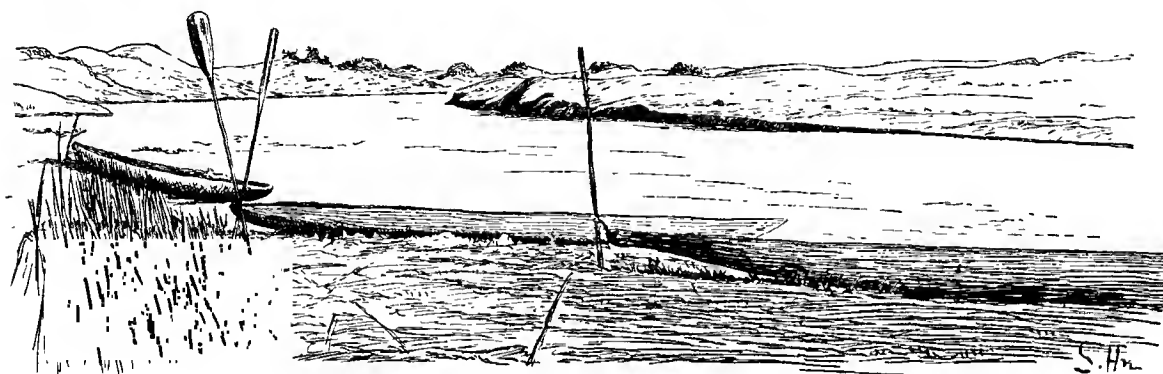


Fig. 402. THE LAJLIK-DARJA AT CAMP XXXII.

to 5.50 meters; hence this lake was a good deal deeper than any part of the Karakoschun. In the upper reaches of the lake the presence of a pretty powerful stream was revealed by the sedimentary deposits in its middle; here it was like navigating a big river with widely inundated banks. Soon the lake did indeed contract into a veritable river, with muddy water, and tamarisk-mounds and barren sand-dunes on its banks, these last bearing signs of recent formation. We pitched our camp on the right bank, the soil all round for a great distance being wet, a proof that the water had recently covered a much greater area, probably after the thawing of the ice. The lake-system which we threaded that day was thus wedged in between genuine sand-dunes, the water having forced its way through the sandy desert. The dunes which rise on the east shore of the lake are considerably higher than those which we had shortly before crossed whilst on the way from Altimisch-bulak to Kum-tschapghan (vide vol. II). Of this stretch of desert I shall give later on a connected description; here I will only mention, that the arrangement of the sand is precisely what might be expected, for it is driven south-westwards by the north-east wind, until it comes into collision with these sheets of water. Its ultimate endea-

your is to fill up all these lake-basins, and it is only the river-arms which carve their way through it that are able to withstand it. Here the steep leeward flanks are regularly turned towards the south-west, not towards the west-south-west, as they usually are in the Desert of Tschertschen. In the Desert of Lop the prevailing wind appears to blow from the north-east, and still farther west to incline towards the west-south-west, so that its general course appears to describe a gentle curve round by the west.

The stream beside which we had pitched our camp (No. XXXII) is called the Lajlik-darja, or the Mud River. On the morning of the 21st April it had the following dimensions: breadth, 25.52 m.; mean depth, 1.579 m.; mean velocity, 0.4616 m.; and volume, 18.60 cub. m. in the second. Thus from this point as far as the Karaunelik-köl there was a loss in volume of 4.0 cub. m.; this is to be attributed partly to the slight fall that occurs after the ice thaws, but principally to the heavy absorption which goes on in the big desert lakes (Tschong-köl, etc.), and to the evaporation over the same extensive sheets of water.

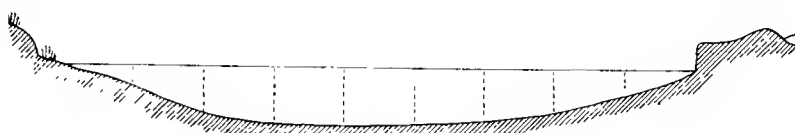


Fig. 403. Right. 0.77 1.93 2.26 2.22 2.15 2.03 1.77 1.08 = depth. Left.  
 12 38 34 40 69 78 67 40 }  
 0 35 36 42 69 76 76 40 } velocity.  
 23 43 41 68 62 70 }

Breadth = 25.52 m. Lajlik-darja at Camp XXXII; April 21st. Scale 1 : 300.

The farther we advanced the more definitely the river-bed became marked. At the same time the kamisch grew both denser and more abundant, and in one place there was actually a clump of 20-year-old poplars. At the point where the Lajlik-darja enters the northern part of the Kötäklik-köl it is easy to see, even on a cursory examination, that the flowing water is waging a war of extermination against the stationary water. The river is, as the name itself indicates, very muddy, whereas the lake-water is practically clear. The muddiness is for the most part occasioned by the finer masses of sand partly slipping down the dune-sides and partly being eaten away by the river itself. It is of this material that the well-developed delta is formed that appears in the northern end of the lake, whence it is extended a good bit farther south in the shape of two parallel lines of mud-banks. These however are in great part invisible, being just below the surface, so that I often wondered why my canoe-men made such wide deviations out into the middle of the lake; their real object was of course to avail themselves of the deeper water, although the current, that runs between the mud-banks, was against us. In other words, it is possible to observe not only the current, but also the formation of the incipient river-bed, out in the middle of the lake. The mud-banks which are forming outside the river-mouth are growing quite fast, and will soon afford foot-hold to kamisch and driftwood. This will of course render them firmer; they will coalesce, the intervening spaces will fill up with sand and dust, and so become gradually converted into firm ground. At the same time the delta will continue to advance farther south-

wards; its formation is already prepared, and its progress will be facilitated, by the two lines of mud-banks, which already indicate the channel in which the river will eventually flow. And when the northern part of the Kötäklik-köl is in this way filled up, it will be the turn of the southern parts to undergo the same fate; and the process will of course be rendered easier through the ability of the prevailing wind to project the sand forwards to the water-line. The masses of sand describe here, within a limited area, a species of circulation. Travelling south-west, they are seized upon by the water, which deposits them in the form of sand-banks; then, after the lake has become filled up, and the flanks of the sand-banks have become exposed and dried, the sand once more begins its wandering in the shape of something intermediate between fluviatile dunes and desert-dunes, or more correctly after a brief *intermezzo* as fluviatile dunes they will continue their migration in the form of ordinary desert or continental dunes. This is precisely the same process that we have already found going on beside the Tarim below Karaul, though on a larger scale and there occasioned by a different cause, namely the river's own migration towards the right.

Seeing however that the flowing water is endeavouring to obliterate the lakes, it may sound like a contradiction when I said, that I found the lakes below the Lajlik-darja greater in 1900 than they were in 1896. But it must also be borne in mind, that all the way from the embouchure of the Lajlik-darja right down to the Karaunelik-köl, there does not exist, properly speaking, a single yard of river-bed, but only lakes, and these are so extensive that the current is seldom perceptible. Thus the sedimentary matter of the Lajlik-darja is arrested, and settles only in the northern part of the Karaunelik-köl. If, then, as we shall indeed find to have been the case, there has been an increase in the quantity of water during the four years, the increase must be shown in the expansion of the lakes on all sides, the water penetrating amongst the dunes, dead forest, and kamisch. Now the country is so extraordinarily flat and level, that even a slight augmentation in the amount of water is sufficient to give rise to a very extensive expansion of the water areas, and so shallow are they, that I only once obtained a depth of 5.5 m. But since the river in this way keeps on thrusting its bed farther and farther southwards, absorbing one after the other the lakes that lie in its path, its channel must obviously be more pregnantly developed the farther north it lies; and in point of fact I did subsequently ascertain that the Sadak-köl was in 1900 considerably less than it had been in 1896.

Above Camp. No. XXXII the river was rather winding until we reached some small lakes. These again contained numerous sedimentary deposits, and the channel of the stream was everywhere distinctly perceptible through the tranquil water. After that the river is first broad, then narrow, having already filled up the lakes that formerly existed here. On both sides it is bordered by high barren dunes. The velocity amounted to 0.67 m. in the second, the water foaming off the bows as our canoe-men plied their paddles with a will against the current. There was a satma on the right bank, but it was, as it happened, uninhabited, its owner having gone to Tscharklik. This is the most important place in the Lop country, and the majority of the inhabitants usually go there at this season of the year to cultivate

the ground. Every now and again, though not really very often, we observed older toghraks, still quite vigorous. Next comes a chain of long narrow lakelets, sending out ramifications in every direction, but all alike embedded amongst the sand. It is evident that the large dunes which occupy the narrow strip of ground between these lakes and the Tarim, without however quite touching the left bank of the river, travelled into their existing positions at a time when the eastern waterway did not yet exist. Their advance has been cut short quite recently by the formation of this waterway, because they rise to the same altitude on both its banks. The reason they do not reach the bank of the Tarim is to be sought in the assumption I have already posited, and had confirmed, namely that at some former epoch the whole of the Tarim system discharged through this eastern waterway, and that it continued to do so a sufficient length of time to allow of the dunes, which were then on the west side of it, advancing a long way from it in that same direction; just as we have already ascertained, that there exists at the present day on the west side of the Tarim a zone that is free from sand.

The kamisch and sedge continued to increase as we advanced northwards. The fact of fishing-nets being set at intervals was a proof that there were human beings somewhere not far away. Next followed a lake of medium size, across which we paddled steadily towards the north-north-east for a pretty long stretch. Finally we pulled up beside five kamisch huts, which turned out to be the same fishing-village in which I spent a day during a storm in 1896. But how changed the aspect of the scene! Had I not already determined the position of the place, and remembered the natives themselves, and the situation of their huts, it would have been perfectly impossible to identify it. The name of the village is Märdäktik; that of the lake, Sadak-köl. This last, which four years previously had been pretty large, was now in great part overgrown with reeds, and filled up with sand and mud. The sheets of open water that remained were not large, and the greatest depths south of the village amounted to 2.25, 2.30, and 3.75 m. Thus the transformation of lake into river had here taken a distinct step forward.

One of the older men of the village told me, that in the autumn of 1899 a natural river-arm had been formed eastwards, coming from the district of Kumtscheke, and that its water had reached his village about a month later. Immediately east of the village there is a patch of high sand, from the top of which I understand it was possible to see this new waterway, which entered the lake east of the patch of sand in question. I at once visited the place, making my way along the reed-grown base of the dunes, and found the statement quite correct: the new stream did enter the lake by two small arms, and they had a pretty lively current. North-east and east-north-east there was a lake which extended as far to the north as the dunes would permit us to see. The only vegetation in the Sadak-köl is a belt of reeds along the southern shore. Here and there are living poplars, some young, some of moderate age; from which it is fair to infer, not only that there has been water here before, but also that the ground-water has remained sufficiently near to the surface to prevent the trees from dying. The lake sends off polyp-like arms in every direction amongst the dunes; these last appear to have been to some extent levelled down since the country was first overflowed. From the southern end

of the lake issues a canal, which near its embouchure divides into two arms. Of these the upper one had a breadth of 2.27 m.; a mean depth of 0.54 m.; a mean velocity of 0.88 m.; and a volume of 1.08 cub. m. in the second. The lower branch consists of a shallow part (5.3 m. broad, 1 dm. deep, 0.4 m. velocity, and a volume of 0.2 cub. m. in the second), and a deep part, of the following dimensions: breadth, 3.3 m.; mean depth, 0.79 m.; mean velocity, 0.83 m.; and volume, 2.164 cub. m. in the second. Thus the total volume amounted to 3.444 cub. m. in the second. Later on, I ascertained that this water came from the lake of Märdäk-köl, which I discovered in 1896. The name of the village indeed alludes to the fact. But the really interesting feature about this new river-system is that it points to the correctness of the idea I first threw out in 1896, namely that the water in this region is tending towards the east, just as the Kara-koschun is tending towards the north, in other words, is returning to the former bed of the Lop-nor. Whether the Märdäk-köl, that is the new lake situated east of Märdäktik, sends out any arm towards the east, I am unable to say; if it does, the arm in question would be analogous to the Tokus-tarim, and it is not unlikely that sooner or later it will be formed, if it is not formed already.

Eight years ago one of the older men of Märdäktik, who was by birth a native of Tschaj, came here by chance in quest of new fishing-grounds. At that time there was only little water; but in the very next year the quantity increased rapidly, and then again four years ago there was another noteworthy increase. But within the memory of man the water had never risen so high as it had done that year (1900). Nine years and farther back there existed in this same locality nothing but a series of salt-pools (*daschi*). At that time, too, the river Ilek was very different from what it is now; for it then divided into two branches, of which the eastern one made its way to this point, where it formed the lakes, while the western branch again divided, sending one arm to the Tarim at Almontschuk and the other at Tal-kirtschin, in a district called for that reason Kujusch; here there was a lake which has now disappeared. Thus we again have proofs of how exceedingly changeable these waterways are; scarce a year passes without some radical change or other taking place, so that no detailed map holds good for longer than a short time.

My informant told me further, that when the ice broke up in the lake at Märdäktik — which the natives call simply »köl» — the level was one *karetsch* (0.22 m.) lower than at the time of our visit, and that it was only during the last ten days that it had risen, the cause being palpably the *mus-suzi*. In the height of the summer the level is said to be a good deal lower than it was just then. To the south they were able to give me the names of only three lakes, namely the Kötäktik-köl, Ghilam-köl, and Nias-köl, all plainly either forming part of or connected with the Tschong-köl. The Ghilam was no doubt one of the lakes we had just traversed, this name being unknown to my canoe-men from Schirge-tschapghan. Here too the cold had been more severe than usual that year, and the precipitation more abundant. But the people had not observed any fatality amongst the fish, such as we noticed at Kara-koschun.

On the 22nd April we continued our journey northwards from Märdäktik, crossing first the lake of Sadak-köl, which is on the whole very shallow, although

in exceptional places we obtained soundings of 2.9, 3.4, and 2.8 m. But the lake soon contracted and the current became gradually more distinct. The water was perfectly limpid; the depth, 2.45 and 4.82 m. On our right we had dunes of medium elevation, with a belt of gloriously green toghrak-forest at their foot; indeed several of the trees were actually growing amongst the sand, which was threatening to smother them. Entering a narrow river-arm, we found poplars standing in the bed of the stream, but though they still retained their branches and twigs, they

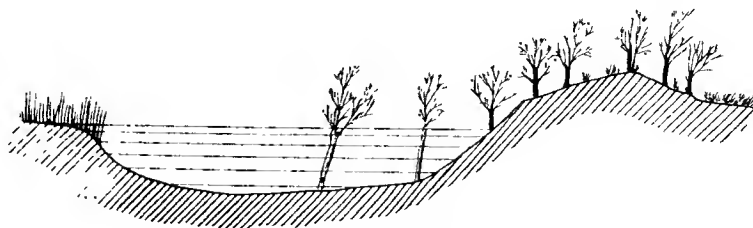


Fig. 404. POPLARS, STANDING IN THE RIVER-BED.

were withered and dead. Seeing that they stand in the deepest part of the channel, one would expect them to have survived the period of drought, for it is incredible that they can have died from excess of water. It is also remarkable, that they still withstand the stream, for its velocity was as much as 1.12 m. in the second, making the water boil off the tree-trunks as it swirled past them. Both these circumstances, the velocity and the trees surviving in the water, are an indication that this part of the river is new. Every now and again the stream expands into minia-



Fig. 405. THE VILLAGE OF KULATSCHA.

ture lakes. At the mouth of the canal of Sait-tschapghan, which enters from the left, the depth measured 4.35 m., and then a little bit farther on 7.10 m. Thus the depth here exceeded the maximum depth of the Kara-koschun by fully 2 m.; but then the marshy bottom of this lake is being more and more levelled up by mud and other substances. The bottom of the stream was distinctly visible, although it was dark, at a depth of 3.10 m. Below Kulatscha we sounded depths of 4.10 and 4.50 m., and in such places as these the current was very slow. The village of Kulatscha was inhabited by one family of five persons, the same as in 1896. From the sandy hills behind the village we saw no sand towards the west, but on the contrary plenty of vegetation (*jangal*), next the river poplars, then dense beds of kamisch, tamarisks, and their mounds. To the east stretched the sandy desert. Here then the Ilek makes the same sharp dividing-line between dunes and vegetation as it does beside the upper lakes and in that part of its course which lies immediately north of them. In a word, this eastern waterway acts as a sort of breakwater against the sandy »waves» of the Desert of Lop: its actively flowing current prevents the encroaching sand from overwhelming the left bank of the Tarim.



Fig. 406. THE RIVER ILEK SEEN FROM KULATSCHA.

Above the village a *tschapghan* goes off to Almontschuk. The big bend in the river below Kum-tscheke had not altered in either form or appearance during the four years. The only thing fresh was a bridge, called Dap-karan (or *-karanlik*), spanning the stream, its purpose being to facilitate the passage of the flocks from the one bank to the other. It is constructed of poplar-trunks, branches, faggots, and kamisch, and at the then existing level was so low that we could with difficulty

paddle underneath it. Below the bridge the velocity was 0.4 m., above it only 0.12 m. The forest here is often especially thick and luxuriant. Sometimes the river is serpentine, then again for considerable distances it flows tolerably straight, presenting at such times quite a picturesque panorama, its dark and silent waters winding through thick reed-beds and lofty forests.



Fig. 407. THE INHABITANTS OF KULATSCHA TOGETHER WITH MY CANOE-MEN.

The huts of Kum-tscheke still stood at a sharp bend of the river, on the high left bank, the sand of which is bound together by vegetation, and were inhabited by the same two families (one *ujlik* of nine persons; none at Tscharklik) as four years previously. These people possessed 30 sheep and two horses, besides some cows, dogs, cats, and poultry. Besides, they were looking after 300 sheep belonging to a *baj* in Tscharklik, who happened to have just arrived to fetch his spring wool. Here I learned that the level of the Märdäk-köl was half a *kulatsch* (86 cm.) higher than on the occasion of my first visit; from which it is to be inferred that the whole of the eastern system had experienced a similar rise, though this is not very probable. The lake sends out one emissary (*sollak-su*, i. e. a stream without discharge) towards the north-east, and is, besides, continued in a series of lakes all the way to the Sadak-köl, where we had observed its outfall. Nevertheless the Märdäk system of lacustrine waterways is said to be entirely cut off from the river in the height of the summer. When the *Ilek* begins to drop, a portion of the water in the Märdäk-köl flows back to it; it is the remainder that gets cut off, and this turns rather brackish during the summer. Wild camels are reported to show them-



selves not infrequently on the eastern bank of the Märdäk-köl: they come from the east, out of the Desert of Lop, whither they also return when they are disturbed. About a year previously a troop of fifty had been seen east of the Sadak-köl; but this number is certainly an exaggeration.

The Ilek was now said to be at its highest, and was expected to begin to fall in the end of May. During the summer it drops a finger's breadth every day; but during the autumn it rises again. It has little or no *kömul*, and freezes in the same way as a lake, a consequence no doubt of its great depth and in general its small velocity. The Ilek had never before contained so much water as it did that year. Upon comparing this information with what we know about the Tarim, we find that the river-system is working its way back towards the east; for whilst the Ilek is said to be bigger than ever before, the Tarim is reported to be smaller.



Fig. 408. THE BRIDGE OF DAP-KARAN.

Here again the winter had been severe; the natives declared it was a good thing they had such an abundant supply of fuel, »otherwise they would have been frozen to death«. The snow had been 2 dm. deep, a very unusual thing. The toghraks and kamisch were two weeks later than usual in beginning to shoot; and the gnats were later in putting in an appearance. Kum-tscheke is also called Kum-modschuk, or Sandy Cape.

On 23rd April we made an excursion to the Märdäk-köl. The canal conveying water from the river into the lake, which in 1896 I rode over with ease, was now so deep »that the water reached to the upper lip of a man standing up in it«. We paddled down-stream therefore as far as the bridge, and then followed this *atscha*, which soon expanded into narrow lakelets, for the most part overgrown with vegetation. Here nets were set out at intervals, as they were also in the canals that run parallel to the river, though they speedily rejoin it. Next we pene-

trated a winding channel, with a lively current, which expands sometimes into small basins (4.15, 2.12, and 4.30 m. deep), and finally bends to the south-west, winding its way through a labyrinth of tamarisk-mounds. This channel, after leaving the older watercourse, the Kona-akin, on the left, divides into two branches. Of these the one on the right goes to a recently formed, but rather small, lake called Tschong-köl; that on the left, the one we proceeded along, flows past the circular wall of Märdäk-schahr, still occupying for the most part the position it did before, that is to say a tongue of land almost entirely surrounded by waterways.

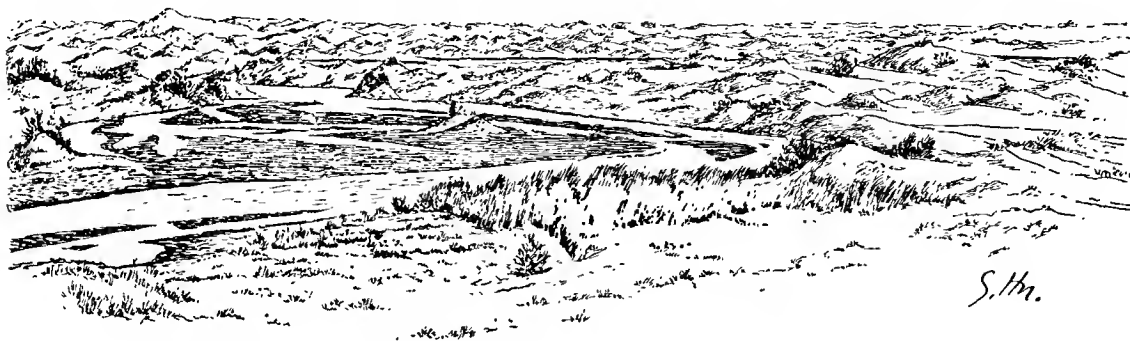


Fig. 409. THE JANGI-TARIM WINDING THROUGH THE DESERT FROM MÄRDÄK-SCHAHK TO SADAK-KÖL.

A couple of years ago a Chinaman, with two Lopliks to help him, spent some time digging for «treasure» here, but found none. From that point the channel goes east, and finally south-east, winding in big curves amongst the tamarisks and dunes to its embouchure, already described, in the Sadak-köl. The name this stream bears there is Jangi-tarim, or the New River, and the greatest depth we sounded in it amounted to 3.60 and 3.65 m. On the right we noted a group of 6 toghraks, 40 to 50 years old, called for that reason Kök-toghrak, or the Green (i. e. fresh or living) Poplars. From the top of a tamarisk-mound in the vicinity we were able to see, as on a map, how the stream winds away amongst the dunes. But there does not appear to be any channel proceeding towards the east.

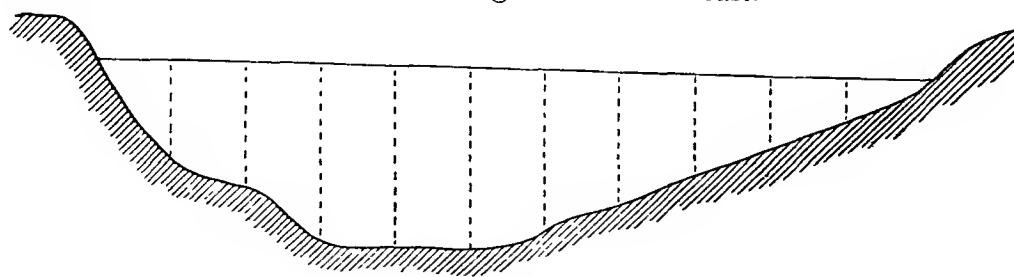


Fig. 410. Left. 

1.26	1.69	2.29	2.30	2.28	2.04	1.71	1.31	0.93	0.59
0	2	27	37	76	66	56	68	51	35
0	0	8	31	72	69	65	56	50	39

 = depth. Right. } velocity.

Breadth = 11.06 m. The branch feeding the Märdäk-lakes; April 23d. Scale 1 : 100.

On our return we paddled into the Tschong-köl, and obtained soundings of 7.4 and 5.2 m., or depths of 2 m. in excess of the Kara-koschun. If all this flat region were to be freed from water, the Kara-koschun would thus not be its deepest depression, only its relatively most extensive one. From this lake Tschong-köl we made

our way by a narrow passage, called Dauleti-boltoso, with a shepherd's hut beside it, into the lake of Dunglik-köl, which, as the name implies, is entirely surrounded by tamarisk-mounds. Both these lakes, Tschong-köl and Dunglik-köl, are marginal lakes, without outflow. Dragging our canoes over a tongue of land, we embarked on the Aghis-köl, paddled south-west across it, and then made our way back to Kum-tscheke on foot. The result of this little excursion was to demonstrate the existence of a recently formed hydrographical system east of the Ilek system; that is, another step in the migration of the main mass of the water back to the old depression of the Lop-nor, lying north of the Kara-koschun. In this movement we have a signal exemplification of the power of running water, for these new overflows, which are bit by bit encroaching upon the Desert of Lop, are literally breaking down the dunes which stand in their path, and with irresistible energy are making their way directly in the teeth of the prevailing winds and the advancing sand-dunes. Thus they furnish a fresh proof that the dunes fall passive victims to the erosive, transporting power of the water. On the whole the kamisch and tamarisks were more abundant in this locality than they had been four years before. My guide, Avullu, who on that occasion also acted as my *cicerone*, assured me that the channel from the Märdäk-köl began to form the year after my visit, but it was not until that very year (1900) that it grew to any great size.

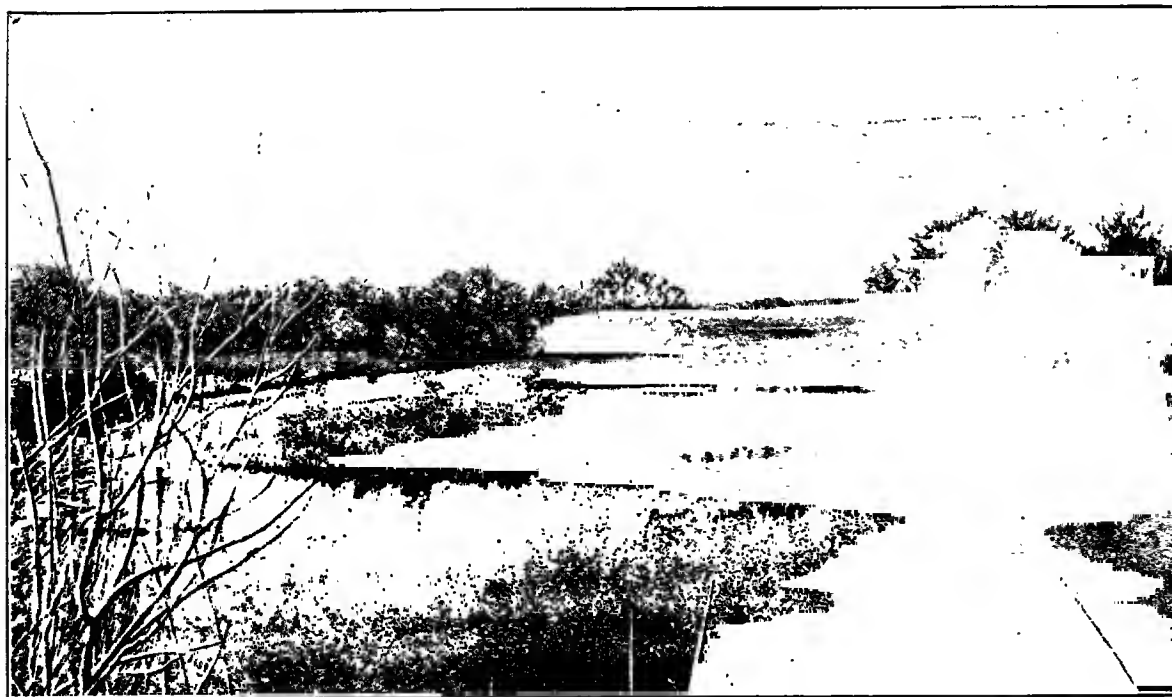


Fig. 411. THE LOW RIGHT BANK OF THE ILEK, JUST OPPOSITE KUM-TSCHEKE.

The stream which issues from the river to feed these new lakes had the following dimensions: breadth, 11.06 m.; mean depth, 1.491; mean velocity, 0.3855 m.; volume, 6.36 cub. m. in the second. Of this volume only a little more than one-half, or 3.444 cub. m., reached, as we have seen, the Sadak-köl; the remainder, 2.9 cub. m., is lost on the way through evaporation and absorption.

From the high dunes of Kum-tscheke, we perceived on the right hand of the river an extensive complex of marshes, small lakes, and lagoons, with creeks or bays, capes, all plentifully supplied with kamisch, and the whole known as Dschajir-köl.



Fig. 412. THE LEFT, HIGH BANK OF THE ILEK; VIEW TAKEN FROM THE SANDY SIDE IN THE VERY BEND OF KUM-TSCHEKE, LOOKING DOWN STREAM.

Resuming our journey on the 24th April, we paddled north against the current; and although the river wound a good deal, its windings were long and easy. To the east of the Ileik lay the elongated lake of Karaune-tokkan-köl; the exit of its canal connecting with the river, just above Dschajir-köl, was almost hidden in the reeds. But higher up this long lake is fed by two other canals from the river. All the way the toghrak forest is abundant, the trees standing close together; everywhere the two rather narrow strips of forest keep close to the banks on each side. These poplars, which have reached quite an advanced age, prove that water used formerly to visit this region too, and that during the intervening arid period their roots were able to reach down to the ground-water. As is generally the case, the toghraks grow most luxuriantly at the sharp bends, where there is a *bulung* («bay»), with deep water swirling gently against the river-banks and moistening them. At one such bend, Toghkak-tscheke, or the Poplar Bend, the old trees stand close together in dense clumps. Some of the bends have worked their way in amongst the outliers of the eastern sand, and in such places the dunes go down steeply into the water. Between the Tarim and the Ileik there is said to be, at this latitude, a belt of sand, which however was not visible to us owing to the north-east (N. 55° E.) storm then

raging, bringing with it its usual accompaniment, the dust-haze, so that our view was circumscribed. But the high banks and abundant vegetation screened us from the worst of the tempest.



Fig. 413. VIEW OF THE ILEK, LOOKING UP-STREAM FROM KUM-TSCHEKE.

Above the Karaune-tokkan-köl is the Basch-köl, a sort of division of the former, both lakes being fed by the same two canals. All these small lakes lie quite close to the right bank of the river, only one or two hundred meters distant, and have no connection with the Tarim. The next lake is the Barat Kulning-köli, the biggest of them all; it lies a little farther away. The river (Ilek) still continues to present the same appearance, being narrow and disproportionately deep, with a sluggish current, and perfectly limpid water, which glances a blackish green when viewed against the predominant yellow and green tints of the landscape; in fact, it looks like a river of ink. Kamisch grows on the edge of the bank, for it is only where the sand actually touches the loops that the banks are



Fig. 414. TOGHRAK-TSCHEKE.

bare of vegetation. Trunks of trees and kamisch stubble lie rocking on the water, and where they fail to come up to the surface they constitute a danger for the canoes. The poplars hereabouts are said to be in general about 40 years old.



Fig. 415. THE ILEK A LITTLE ABOVE KUM-TSCHEKE.

After this we reached the important point where the Ilek receives, on its left or eastern bank, its tribute from the Arka-köl and the other lakes situated north of it. At its entrance into the river the mouth of the connecting canal is rather narrow, but a very little higher up it widens out, and is shut in by poplars. A little bit higher up still the river is joined by yet another though quite insignificant branch, it too hidden amongst the reeds. Thus I was at length in a position to complete my map of 1896, and at the same time to correct a serious error which had crept into it. I took it for granted that the Ilek of Kum-tscheke is derived wholly and solely from the chain of lakes consisting of the Avullu-köl, Kara-köl, Tajek-köl, and Arka-köl, and is the channel by which they discharge. But I have now ascertained, that the distribution of the water is much more complicated, and that the only discharge out of these lakes is through the two small channels I have mentioned. Where the Ilek really does come from we shall see soon.

The inhabitants of Kum-tscheke possess here a hut, Islamning-ujj, on the left bank of the Ilek. Here too the river makes a pretty abrupt bend, penetrating in amongst the overgrown dunes on the left (eastern) bank. The river-bed is shallow, and

consequently the current is pretty swift, as appears from the section appended herewith. Thence our course was south-west as far as a point where a not inconsiderable portion of the volume turns into the Barat Kulning-köli. Although the entrance (*aghis*) is single, the stream soon divides into two canals, one broad, the other narrow; both traverse a broken poplar forest until they reach the lake, which is so far distant that it cannot be seen even from the top of the high tamarisk-mounds. A little above this point we encamped (No. XXXV) amongst the sand-hills, tamarisk-mounds, and dead toghraks. Thence we saw N.  $55^{\circ}$  E. the southern part of the Arka-köl, with a pretty large area of open water, which became lost to sight northwards amongst the reeds. The space intervening between the Ilek and the Arka-köl is occupied by long ridges of sand and by tamarisk-mounds, with an occasional toghrak, dead or living, amongst them. The eastern shore of the lake was lost in the haze, but I knew what it was like from having seen it in 1896.



Fig. 416. THE ILEK NEAR TOGHRAK-TSCHEKE.

During the course of the day I obtained the following measurements: at Kum-tscheke, breadth, 16.75 m.; mean depth, 2.760 m.; mean velocity, 0.5134 m.; volume, 23.73 cub. m. in the second. The last preceding measurement below the Sadak-köl had resulted in a volume of 18.60 cub. m. in the second. Adding to this the 6.36 cub. m. of the Märdäk-köl stream, we get a volume of 24.96 cub. m., or 1.2 cub. m. more than at Kum-tscheke. Considering the loss of water by the way, one would have expected the contrary; but possibly the Ilek had dropped somewhat during the three days. Anyway the river had lost 5.13 cub. m. between the Lajlik-tarim and Kum-tscheke.

The canal from the Arka-köl was difficult to measure because of the kamisch. Although its embouchure was 25.66 m. across, the actual current was only 3.65

m. broad; amongst the reeds and in the lagoon on the left the flow was very feeble. Confining ourselves to the actual current, we obtained a mean depth of 2.163 m., a mean velocity of 0.392 m., and a volume of 4.0 cub. m. Estimating at 2 cub. m. the amount that flows through the lagoon and the reeds *plus* that which makes its way through the tiny upper branch, we get a total of about 6 cub. m. for the entire volume issuing from the Arka-köl, or exactly one-half the amount (12.12 cub. m.) which I ascertained in the upper Ilek (the Ördäk-jaghutsch-tarim) in the beginning of April 1896, and which, in view of the stability of the Kontsche-darja, had probably not essentially altered during the four years. These 12.12 cub. m.

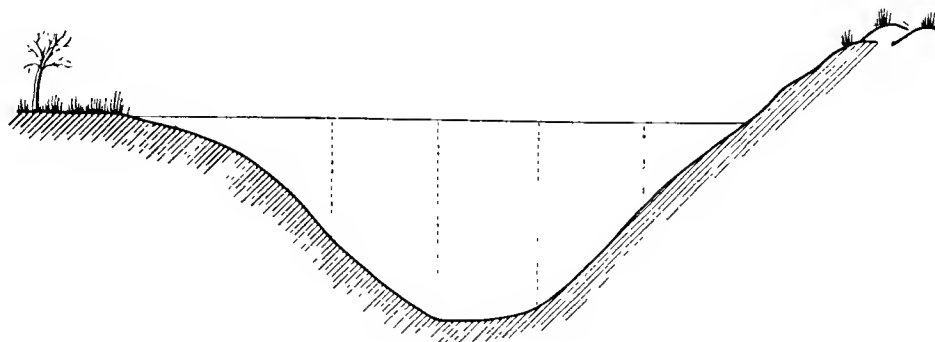


Fig. 417. Right.    0.02    3.26    5.38    4.98    2.02 = depth. Left.

○	31	50	65	38	} velocity.
○	50	67	72	51	
	47	64	70	45	
		65	67		
		61	72		

Breadth = 16.75 m. The Ilek at Kum-tscheke; April 24. Scale = 1 : 200.

do not however represent the whole of the volume which enters the chain of the Kara-köl lakes, and in point of actual fact these do absorb a good deal more than 6 cub. m. Even though the whole of the 12.12 cub. m. entered these big lakes, probably not one drop would flow out of them. In that case they would be like the Kara-koschun, though this receives an incomparably greater amount of water, and would form a terminal lake for the northern Ilek. From what I have said above, it will be evident that at Kum-tscheke only about one-fourth of the volume of the Ilek is derived from the Kontsche-darja, and that it is consequently the Tarim which determines the shifting of the river-bed towards the east.

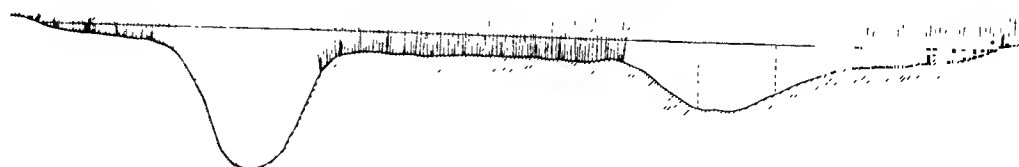


Fig. 418.    1.50    3.25    3.50 = depth.

38	44	28	} velocity.
47	77	49	

1.70    1.32 = depth.

The whole breadth = 25.46 m. The channel from Arka-köl; April 24. Scale 1 : 200.

At Islamning-uji are obtained the following measurements: breadth, 18.55 m., mean depth, 1.997 m.; mean velocity, 0.6129 m.; and volume, 22.71 cub. m. in the



second. At Kum-tscheke the volume was 23.73 cub. m., and of this 6 cub. m. came from the Arka-köl. Hence we should have expected to get at the very most at Islamning-uji only 17.7 cub. m., instead of which we have 22.71 cub. m. Adding this to the amount which comes through the kok-ala of the Arka-köl, and we obtain a total of nearly 29 cub. m. in the second. Thus on the short stretch between Kujusch and Kum-tscheke, the river loses 5 cub. m., this amount being absorbed by the numerous marginal lakes and marshes. The volume at Islamning-uji amounted however to very nearly one-quarter of the volume of the Tarim at Schirge-tschapghan, this last having been 101.86 cub. m. on 19th April.

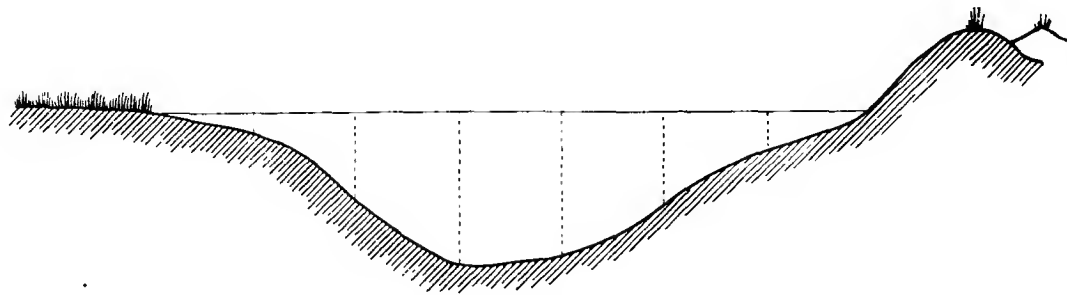


Fig. 419. Right. 0.53    2.40    4.00    3.70    2.40    0.95 = depth. Left.  
                   12        49        70        82        68        47  
                   17        61        68        77        72        47 } velocity.  
                           66        71        78        66  
                                   68        72

Breadth = 18.55 m. Ilel at Islamning-uji; April 24. Scale = 1 : 200.

Finally we measured, just below our camp, the volume that goes to the Barat Kulning-köli, taking the measurements close to the mouth of the canal, with the following results: breadth, 10.60 m.; mean depth, 1.120 m.; mean velocity, 0.4539 m.; and volume, 5.39 cub. m. in the second. Of this amount only a very small portion returns to the river through the lower canal of the Barat Kulning-köli, the current in which was at that time barely distinguishable. The upper canal is said to dry up

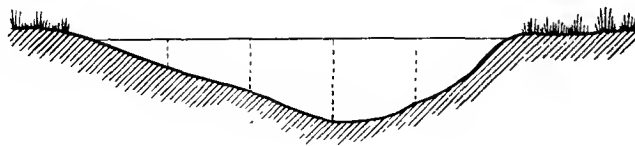


Fig. 420. Left. 0.78    1.42    1.82    1.58 = depth. Right.  
                   54        47        50        50 } velocity.  
                   60        41        46        50

Breadth = 10.6 m. The channel to Barat Kulning-kol; April 24. Scale = 1 : 200.

completely in the height of summer, thus cutting the lake off from the river, in consequence of which it shrinks considerably. If this statement is correct, and I believe it is, it means that in the summer the Ilel drops 1.82 m. (see the section measured above) below its present level. Probably the drop is even greater, for in July it is said to be possible to ford the river in several places on foot, a thing we could not have done then at a single spot, even with camels.

Measuring the river once more at our camp on the morning of 25th April, we obtained the following results: breadth, 20.90 m.; mean depth, 2.279 m.; mean velocity, 0.4614 m.; volume, 21.98 cub. m. in the second — results which were unexpectedly low. At Islamning-uji the volume had been 22.71 cub. m.; a short distance above at our camp, and not quite twenty hours later, it was 21.98 cub. m., and yet there had been a loss of 5.39 cub. m., contributed to the marginal lakes. Thus there ought to have been a volume of 28.1 cub. m. The causes of this oscillation are twofold. In the first place it is perfectly plain that there must be several canals hidden amongst the reeds on the right bank, and screened from observation on the river; and in the second place, it is obvious that not all this volume is derived from the lakes, for they always act as regulators of the amount of water, preventing great and sudden changes, but it must have come from river-arms with varying levels.

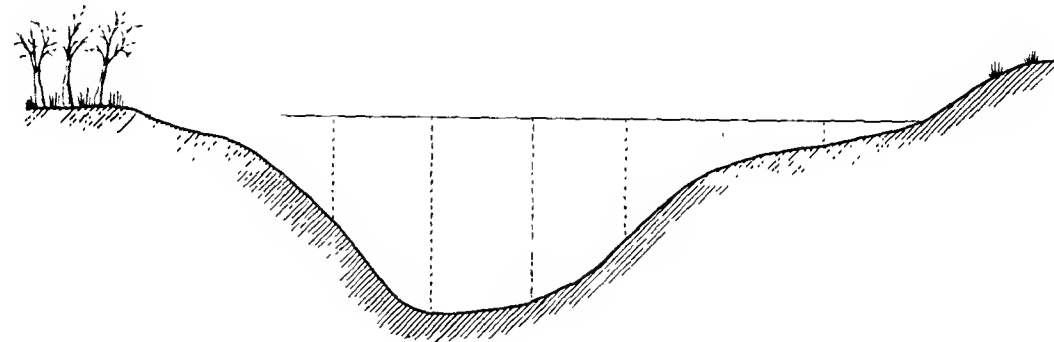


Fig. 421.	Right.	0.80	2.75	5.03	4.77	3.00	1.19	0.61 = depth.	Left.
		11	32	46	58	46	3	0	
		6	47	72	63	50	1	0	
			48	62	67	59			
				62	68	62			
				62	66				

Breadth = 20.90 m. Ilel at Camp xxxv; April 25. Scale = 1 : 200.

The two vertical sections taken at Islamning-uji and at our Camp No. XXXV are strikingly alike; and indeed it is quite natural they should be, seeing that both were taken in loops pointing eastwards, and that, while the left bank of each penetrates in amongst dunes held together by vegetation, the right bank is in each case flat and marshy, and covered with kamisch and toghraks. Hence in analogy with the usual river-conformation in this region, one would expect in sharp, abrupt windings such as these to find the greatest depths quite close to the concave and eroded bank — here the left bank — against which the entire mass of the water is impelled with centrifugal force. But in the two sections in question there is not the slightest indication of any such conformation; on the contrary, the left side is remarkably shallow, and the greatest depths, 4.0 and 5.03 m. respectively, occurred a good deal nearer to the right than to the left bank. Nor is the reason for this incongruent structure far to seek: it must be occasioned by the stream washing down the loose sand on the concave bank, and thus itself levelling up the bed, as also possibly by the sand being blown from the dunes directly into the river; whereas against both these agencies the right bank is protected.

From Camp No. XXXV we traversed a couple of sharp bends until we came to the point where the Sollak-akin (the Stagnant or Suspended Current) enters the river from the north. This channel formerly carried the Ilek, until, according to what I was given to understand, it was deserted by the river about a score of years ago, though the bed itself is still full of water. Leaving this on our right (i. e. on the left bank), we turned in upon the lakes which give rise to the Ilek, steering towards the north-west. The first of these is the Tokaleschti-mandscharighi, with depths amounting to 4 m. The kamisch is here very high and strong, and through it winds a narrow passage, the Osagh-koghul. The next lake, the Podulaklik-köl, is 2.8 m. deep. Here there are several tunnel-like tschapghans, narrow and difficult, through the dense kamisch, which seems as though it were smothering and stifling the young green shoots of spring, that are endeavouring to force themselves up between its coarse yellow stalks. In order to afford the young growths breathing space, it is customary early in the spring to set fire to the old kamisch, and indeed we already observed big black patches of burnt reeds in two or three places. Next in the chain of lakes come the Kum-köl, with depths of 4.46, 4.53, and 6.73 m., and the Tosghak-tschantshdi, with 3.42 and 4.52 m. as its maximum depths. Almost everywhere there was a perceptible current, slight indeed in the lakes, but in the tschapghans quite as lively as in the Ilek. In the last two lakes there were no less than 36 fishing-nets set, and their owners were busy overhauling them as we passed. The nets were quite short and were fastened to two poles stuck into the bottoms of the channels; the natives call them *mandschar*, in contradistinction to the long nets without poles, which they call *gölme*. As regards the fish, I was told that the lean ones come from the Tarim higher up, but that the fat ones belong to the lakes. Fishing, I may add, is also carried on in the lakes.

The two huts of the little village of Tosghak-tschantshdi, situated on the reed-grown bank, embraced 3 ujlik of 19 persons in all. These people do not possess any ground at Tscharklik. They settled here seven years ago. This lake is evidently the one that Kosloff calls Soghot, for it was at Soghot that these people dwelt formerly. But in supposing that the Arka-köl which I discovered is identical with his lake Soghot, Kosloff is in error. For, apart from the fact that Soghot never was a lake at all, but merely a boldschemal or abandoned loop on the left bank of the Tarim, which does not contain water even all the year round, there exists between the Arka-köl and the spot where Soghot formerly stood, yet another lake, namely the Tosghak-tschantshdi. In fact it is impossible to get any clear conception of this tangle of lakes, marshes, and old and new river-arms without personally visiting the region, and mapping them in the fullest detail. The natives declare, that the lake of Tosghak-tschantshdi has been in existence for over twenty years, and before it arose the country was *tschöl*, or »waste»; but this is rendered improbable by the old and magnificent toghraks which grow on the banks of the Tarim. Probably what is true of the river lower down applies also here, namely that a former irrigation period was followed by a waterless period, during which however the poplars did not wither. It is evidently this intervening period that the natives refer to.

Between Tosghak-tschantshdi and the Tarim at Soghot there is a narrow strip of low dunes, something like 3 km. across. Now it is clear that a belt of sand which is interpolated in this manner between these two winding waterways, and between their wind-sheltering forests, must have originated at a time when the country presented quite a different aspect from what it does now. It cannot have accumulated here even during the waterless period of the Ilek; it must have been deposited at a time when the water of the united Tarim and Kontsche-darja was discharged into the old Lop-nor.

Tosghak-tschantshdi belongs to the administrative district, or *tabesi*, of Tikenlik, and Kum-tscheke to that of Tscharklik; hence the boundary between the two districts runs between these two places.

We now steered north-east across the lake (depth, 3.36 m.), and so returned to the Sollak-akin (also called Kona-akin), the old bed of the Ilek, which here is also used by the water. Hence it is only that part of the river-bed which lies east of Tosghak-tschantshdi which was deserted about 20 years ago. In this upper part of the Sollak-akin the current was extraordinarily slow, often imperceptible, a result partly due to its great depth, 7.5 m., partly to the fact that there were other currents running through the reeds. On the whole this river-bed presents precisely the same appearance as does the lower Ilek: the water is deep, dark-coloured, and bright, and the banks are planted with forest and kamisch. Then leaving this bed on the left, we paddled across a kamisch lake, and into the bay which brought us closest to the shore of the Arka-köl on the east. The tongue of land between the two, 810 m. across, consists of low dunes, with a tiny salt-pool in the middle, and solitary poplars and tamarisks. Across this we dragged our canoe, a smaller one than we used before. On the western shore of the lake the dunes are pretty high, and the reeds all round its shores are tolerably thick. In the creek where we first approached the lake we found a small canoe, a proof of what I had already been told, namely that fishing is carried on in the Arka-köl.



CHILDREN OF THE TARIM.

## CHAPTER XXIX.

### THE ARKA-KÖL, TAJEK-KÖL, KARA-KÖL, ETC.

In this little trip I was accompanied by two men of Tosghak-tschantshdi, one of them being a certain Barat Kullu, from whom the first-mentioned lake of Barat Kulning-köl derives its name (a proof, by the way, that this little lake is a perfectly new creation), and by a fisherman from the Arka-köl, who piloted the way in a small canoe. The fact that we had to cross the tongue of land on foot, and that it is traversed by a distinct footpath, is a proof that there exists no water-connection between the Ilek and the Arka-köl, but that they belong to different waterways, as also that the hydrography of this region is more intricate than I believed on the occasion of my visit in 1896. In this lake fishing is only carried on in the autumn, when, the level having dropped during the summer, the fish are more easily got at. The name Arka-köl has manifestly been given to it by the inhabitants of Tosghak-tschantshdi or Arghan, for Arka-köl means the Back or Farther-away Lake; had the lake derived its name from the inhabitants of Tikenlik, they would have called it the Ajaghi-köl, or the Lower Lake.

The Arka-köl sends out arms and ramifications in every direction. It consists partly of large spaces of open water, but is also in part overgrown with a dense tangle of kamisch and jākän; in the south, where the Kok-ala issues that drains it into the Ilek, the vegetation is so exceptionally luxuriant, that even after setting it on fire, it would be anything but easy to force a way through it. Here then it is a perfect wilderness, into which human beings never by any chance venture. It is easy to understand, that the water which filters through reeds of this description enters the Kok-ala as pure and clear as crystal. Year after year fresh generations of kamisch spring up in these marshes, and as they do so, they strive their utmost to make themselves room by thrusting aside the dried stalks of the preceding year, even though these tower up 6 m. in height, and are two or three centimeters in diameter at the base. From this some idea may be formed of the immense quantities of organic materials which in this way accumulate in the lower part of the lake, where they are collected and compressed by the weight of the water. These dense reed-brakes retain the masses of dust and sand which drop amongst them, and as the years go by the whole forms a continually growing barrier or natural dam, which holds up the water above it, while the lake broadens and expands. Indeed I was told that the Kok-ala forms cataracts below the lake. And

in the changeableness of the hydrographical distribution this factor again plays a by no means unimportant part; as we shall ascertain subsequently, *kamisch* is one of the factors which helps to fill up the basin of the Kara-koschun.

A gentle current can be detected in the narrow passages (*bolto*) between the tamarisk-mounds, which rise straight out of the water. One of these passages is called Kirghuj Pavan-jaghatsch-tscheken-bolto. Broader passages are called *bel*, a term that is applied in mountainous districts to a flat, easy pass. To the south of the western part of the lake there is a patch of barren dunes of somewhat imposing dimensions. On the whole the Arka-köl is considerably deeper than the Kara-koschun; the greatest depths we obtained being 5.28, 5.48, 7.13, and 5.30 m., so that this depression is more accentuated than that of the Kara-koschun. Hence we have reason to suspect, that the Kara-koschun is older than the Arka-köl in its present form, for the former is more filled up, though this is only to a very slight extent caused by the water remaining stationary in it; whereas the current runs right across the Arka-köl, while the barrier at its southern end prevents any solid material from leaving the lake.

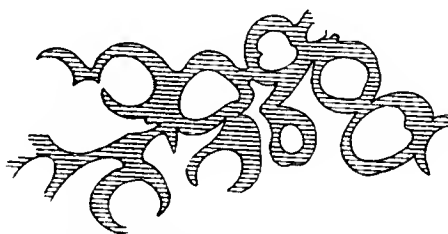


Fig. 422. A VERY IRREGULAR FJORDS ON THE EASTERN SHORE OF ARKA-KÖL; THE DARK PARTS ARE WATER, THE WHITE LAND.

Upon reaching the point where the water is drawn into the Kok-ala, we changed our course and proceeded up the eastern side of the lake, that I might have yet another glance at the chaos of tamarisk-mounds, creeks, small dunes, *kamisch*, and *toghraks* through which I had so much difficulty in forcing my way in 1896. From the top of a mound I was enabled to see how excessively divided and irregular the shore-line is, especially in consequence of the broken surface and the thousands of tamarisk-mounds, amongst which the lake shoots out its ramifications in the shape of minor fjords and lagoons; and inside these there are several sheets of water, slightly salt and cut off from the rest of the lake. While some of the tamarisk-mounds are entirely surrounded by water, others are clasped by it after the manner of crab's claws. Along the shore is a ring of poplars of medium age, and beyond that comes the yellow sand. Vast expanses of *kamisch* and *jäkän* are broken off about one decimeter above the surface of the water, giving them the appearance of fields of stubble over which the reaping-machine has passed. From this one would infer that, when the ice broke up, the lake-level had been one decimeter higher than it was then, though this explanation is contradicted by other explanations that were given to me subsequently.

The yellow *kamisch*-fields extended as far to the north as we were able to see, until they melted into the vegetation of the next marsh, the Tajek-köl. After this



CANOES AT TSCHIMEN.



*Ljustr. A. B. Lagrelins & Westphal.*

A BEK AND HIS ATTENDANTS AT TSCHIMEN.





reconnaissance we paddled back to our point of departure, passing on the way a big patch of sand called Bussup-tüschen-kum, a name implying that a good deal of it has been already washed away. On the west shore of the lake too there are not a few toghraks. The ice was said to have broken up  $1\frac{1}{2}$  months before on the lakes, but two months before on the rivers. In the Arka-köl the water had never before stood so high as it did that year, the cause assigned being an augmented inflow from the Tschivilik-köl.

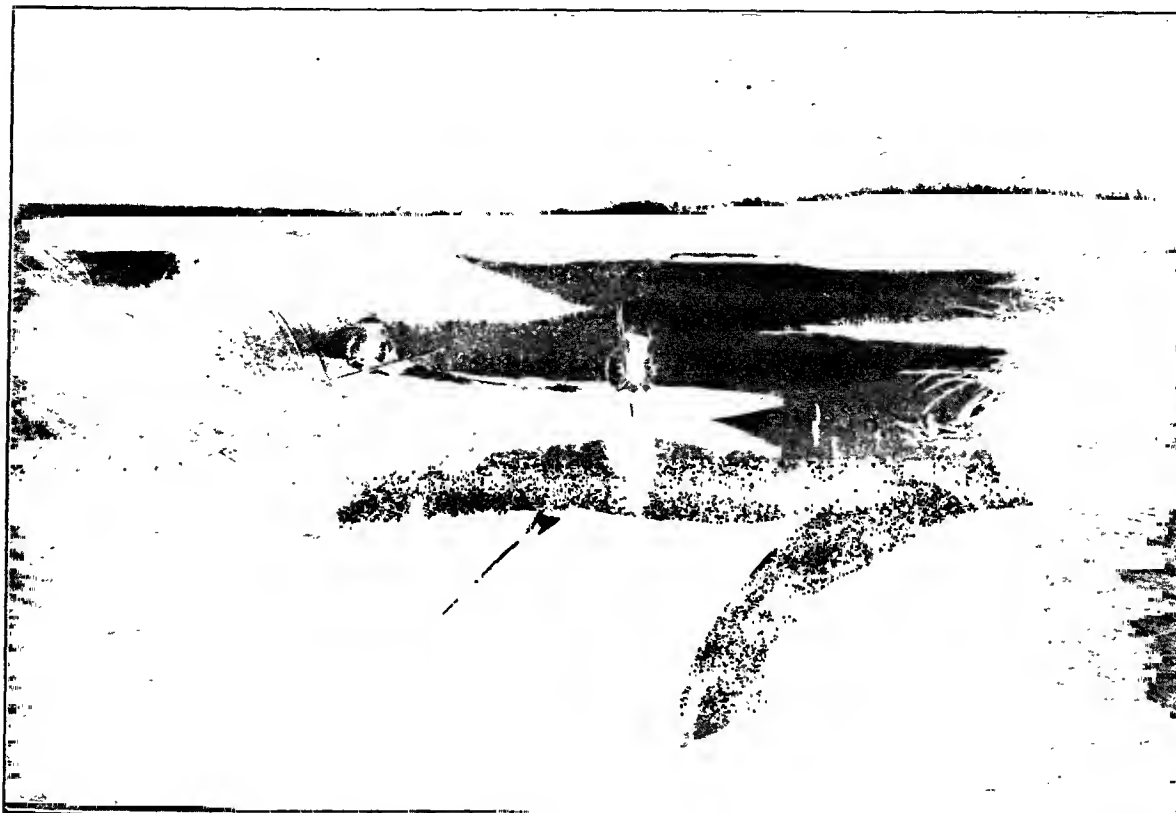


Fig. 423. THE LAKE OF TOSGHAK-TSCHANTSCHDI.

On 26th April we paddled back from Camp No. XXXVI to the village of Tosghak-tschantschdi, and thence northwards through the reeds, and across some small lakes of the usual character, diversified by islands, capes, and reedy tunnels, the kamisch being very tall and strong. The greatest depths we sounded were 3.30, 3.10, 3.76, 4.90 m. At S.  $30^{\circ}$  W. from a point just north of the village there is said to be a small *daschi* (salt-pool) called Schirdake-attasi-avul-tschapghan, surrounded by dunes with vegetation and tamarisk-mounds. On the left (west) amongst the reeds is the mouth of a small canal called Jangi-tarimning-ilek, a confusing name, for there is said to be an old river-bed just here through which formerly the entire discharge used to be poured. The larger channel we were following is called the Jangi-tarim. It is fenced in entirely by reeds. As a rule the current was extremely slow; only once did it amount to as much as 0.49 m. On the east side we passed another old river-bed, the Aru-akkan, its mouth still quite distinct. Immediately above that

point our river is joined by the Avul-gölme-kadaghan-ilek, a branch emanating from the Tajek-köl. Unfortunately it was not possible to measure its volume anywhere, for it is entirely hidden amongst the kamisch, and is in fact more like a lake overflow. There was but a narrow channel open through the reeds, with a moderate current running through it. It is an interesting fact, deserving of mention, that the Kok-ala of the Arka-köl is not the only stream that issues from the eastern chain of lakes. Even though the outlet of the Arka-köl should become stopped up with reeds and other material, the water will always be able to find its way out through the Tajek-köl arm that I have mentioned, and possibly there are several other similar arms hidden amongst the reeds. Here our Ilek, or the Jangi-tarim, was 7.48 m. deep. On its west side lies the little marginal lake of Karaune-tokkan-dschajir; and above it are some poplars of medium age. On the east bank there are nothing but tamarisk-mounds and small outliers of sand scooped out of the river-bends. Another marginal lake, quite close to the west side of the river, is called Töllöndöni-köli. At a sandy bend (Kum-tscheke), called Kötöröma, we measured out in the middle of the stream the great depth of 12.55 m., the greatest I have ever measured in any river in the Tarim system, and indeed the second deepest sounding I have taken anywhere in the whole of the Lop country. In the large desert lakes on the right bank of the Tarim the greatest depth was only 11 m. Absolutely the deepest sounding I ever took along any of the traverses I made either by land or by water through the Lop country was one of 14.0 m., which I got at Markat (vide p. 182). East of the 12.55 m. sounding the Tajek-köl gave a depth of 9.52 m. These three deep places lie pretty nearly on the same latitude, and all of them west-south-west of the basin of Lop-nor. Thus they occur along an elongated depression which lies parallel to the Kara-koschun; and this, even after allowing for the general slope southwards, is considerably deeper than the southern depression which forms the terminal reservoir of the Tarim system. The existence of this northern depression accounts for the origin of the many lakes situated on precisely the same latitude. That these extend north and south, and not in the east-west line of the depression, is due to the effects of the wind, of the drift-sand, of the long chains of dunes held together by vegetation, and of the ramparts which the rivers throw up. But I shall have occasion to return to this depression again, when I come to consider the newly formed lakes which the Kara-koschun has recently sent out towards the north. For the present I will content myself with pointing to the curious fact, that the Ilek at the point I have indicated is more than twice as deep as the deepest spot in the Kara-koschun, or 12.55 m. as compared with 5.15.

Another little lake on the left bank is known as the Uja-vakkan-dschajir. Poplars appear again at Kök-toghrak, on the right bank, where they stand in a clump. At the same time they are more numerous also on the left (eastern) bank, some of them, fresh and vigorous, standing close beside the river, others, dwarf, gnarled, and stumpy, being scattered amongst the small dunes and ridges of tamarisk-mounds. From one of these last, which was lofty and commanding, I took a general view of the locality. To the east lay the broad open expanse of the Tajek-köl, terminated on the east by the thick reeds, and these in their turn are bordered by the dunes and tamarisk-mounds amongst which I travelled in 1896. West, north-

west, north, and N. 10° E. was an ocean of reeds, interrupted at intervals by patches of open water. Our Ilek is separated from the lake by a long, narrow ridge of sand, with living and dead tamarisks, as well as lusty poplars. These last also accompany the left bank of the river throughout, whereas the right bank is lined with nothing but kamisch and perplexing marginal lagoons, which rendered it impossible to measure the river. Far away in the west the extensive marshes appeared to be likewise bordered by sand-ridges with tamarisks. One would be tempted to set down the entire expanse as a single gigantic marsh, were it not that the eastern waterway of the Avullu-köl and Arka-köl forms an independent system, distinctly separated from our Ilek by the long, narrow ridges of sand. This arrangement is however peculiar, in so far as the Ilek lies only one kilometer west of the lacustrine chain, and yet these cannot be regarded as being its marginal lakes. One thing is at any rate certain, that it is anything but easy to map a marsh, a labyrinth of river-arms and lakes, amongst which the hydrographical distribution is subject to such incessant and such sudden changes. The only thing that can be done is to proceed as I did, namely trace out one of the main arteries, and ascertain how the other waterways and basins are arranged on each side of it.

At this point, then, 710 meters from the west shore of the Tajek-köl, we encamped; and as we had done at the Arka-köl, we carried a canoe over-land and launched it on the lake. This lake is evidently bigger than the Arka-köl; the poplars beside the upper part of the Arka-köl were visible S. 70° E. The natives describe the Arka-köl as being *jilgha*, that is »long and narrow», but the Tajek-köl as being *jumalak*, or »round» in shape. The shores of this latter, again, are almost everywhere smothered in reeds, so that a couple of transverse intersecting lines across the lake are not sufficient to afford an idea of its outline. At first it was not easy to get out of the thick belt of reeds which border the western shore, and reach the foot of the separating ridge of sand; but we did succeed at last, and then found ourselves on the edge of a wide expanse of open water, with a little island, consisting of a single large tamarisk-mound, on our right. Out in the middle of the lake the current setting towards the Arka-köl, although sluggish, was nevertheless distinguishable. Generally the lake is so deep that its bottom is seldom visible. The natives know very well where the deepest parts are, and these we now sounded, obtaining depths of 5.70, 9.52, 6.90, 4.03, 4.90, 6.72, and 7.90 m. Unfortunately we were unable to force our way through the tangled reed-brakes on the east side of the lake to the dunes and tamarisk-mounds lying only a few hundred meters beyond. Accordingly we turned north, and paddled with the current, though it was so gentle that we seldom noticed it. On the left we had Karaune-tokkan-toghrak, or the Poplar in which the Karaune-bird lays its Eggs. At a spot close beside this, where the current was plainly perceptible, it is called Karaune-tokkan-ilek. Both the *karaune*, a big black swimming bird, and wild-duck are very plentiful here. We saw two or three fishermen from Tosghak-tschantshdi busy plundering the nests of the latter. The next place where the current was distinguishable is called Mandschar-baskan-ilek. Then we travelled south, crossing two tongues of land and a pool. The next name is Taschtane-köli. Here too the lakes and their several parts are named after the men who began fishing in them, and claimed the sole rights to fish there. Two such

parts of a lake south of our route are known as Toktaghone-kölö and Ansane-kölö; and Sait Bakini-kakbasi is a small lake lying S. 20° W. Here again fishing is only carried on in the autumn after the water has dropped. North of our route we observed during the greater part of the day sand-ridges held together by scanty vegetation. The Tajek-köl is really connected with the Kara-köl, although impenetrable reed-brakes stretch between them.

At this camp we were tormented by gnats, which filled the air in perfect clouds; we were therefore glad to be off again shortly before sunrise on the morning of 27th April, whilst the air was still cool from the night, though unfortunately it did not long remain so, for the hot season had now set in in earnest in this region. We had not gone far before it began to blow pretty strongly across the marshes from the south-west, and although it was a soft, warm wind like the simoom, it nevertheless caused the air to circulate and kept the gnats at a distance. We were now proceeding up the Ilek. It still preserved the same character and appearance as heretofore, i. e. it was smothered in kamisch, and thus was more like a passage through a reedy lake than an actual river; on the west the kamisch *jangal* (forest) extended in fact as far as we could see. On both sides of our route there were lakes and marshes, though on the east the belt of lakes was but narrow, as we could see from the rounded sand-ridges, tamarisk-mounds, and poplars which towered above the kamisch. The features of this peculiar region are illustrated in the accompanying little sketch-map: the only fixed points for the eyes to rest upon are the firm ground of the sand-hills on the east of the lakes. The river gives the impression of not flowing along any definite bed, but of making its way through an inextricable tangle of lakes and marshes. Nevertheless it keeps open a passage for itself through the reeds; probably the main reason is that the trench in which it flows is too deep for the reeds to establish themselves in it.

Our direction was north, with an inclination to the east, until we came to Suji-sariktake-uj, a hut standing amongst dunes planted with toghraks, where we turned to the west, with an inclination to the south. Next we crossed over the lake of Suji-sarik-köl, an elongated sheet of water stretching in that direction. Its depth amounted to 3.14 and 4.57 m. Out of this open basin we plunged into the most disagreeable tschapghan I have ever seen. It was a long time since it had been cleaned out, and the heavy masses of reeds, broken by the wind, hung in a dishevelled tangle across the channel, converting it into a dark, narrow, stifling tunnel. The men were obliged to use their paddles to clear a path for the canoes. In some places the prostrate reeds, which grew in 2 m. of water, were so compact that one of my men was easily able to walk on the top of them. It was interesting as well as instructive to see with one's own eyes how important is the part played by the fine material, with which in spring and summer the atmosphere of East Turkestan is loaded, in filling up these shallow lake-basins. The thick reeds were so interpenetrated with it that at the least touch clouds of dust arose, choking us worse than the dustiest of highways. By drawing my hand along a single long stalk of kamisch I was able to get it almost full of dust. Nowhere have I been more forcibly impressed by the power which the kamisch possesses of retaining and binding together the matter that floats in the atmosphere. This falls, as I have already

stated, throughout the whole of the country, but while that which alights upon dry land is whirled up again by the next storm, that which drops amongst the kamisch remains immovable. Nay more, those strata of the atmosphere which sweep through the kamisch undoubtedly discharge amongst it a quantity of the matter with which they are laden, and which consequently contributes to the »shallowing» of the lake-basin into which it settles. The dissimilarity between land and water in this respect is one of the most important of the factors which co-operate to produce the incessant changes going on in that region, a dissimilarity which, as we shall subsequently find, is especially marked in the Desert of Lop. While matter is being constantly abstracted from the land surfaces, it is simultaneously just as unceasingly being accumulated in the water areas. In other words, it is another form of the levelling work performed by the agency of the wind.

The seed-vessels of the *jäkän* would now at the least touch whirl up and scatter through the air like smoke. The vegetation in this region is so luxuriant that it is amazing it has not smothered itself in the plethora of its own excess. Only once or twice did our winding course lead us across small patches of open water, ten or a dozen meters in diameter. It was still identically the same lake we were in, it being the western part that is thus overgrown with kamisch. The water which issues from this lake, the Suji-sarik-köl, after thus filtering through the reeds, pours itself into the *Ilek*, the stream we had just paddled up. It was quite a relief to get out upon the *Ilek* again, which, although its velocity did indeed increase as we advanced, still continued to bear little resemblance to a river.



Fig. 424. A RELATIVELY OPEN PART OF THE  
»TSCHAPGHAN» OF SUJI-SARIK-KÖL.

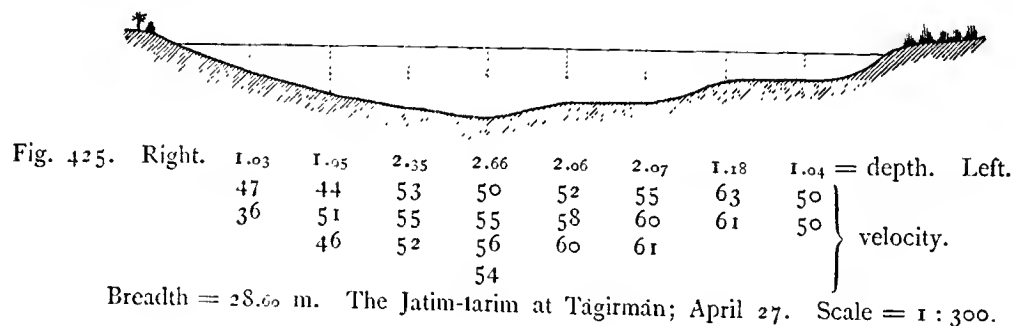
Opposite to a *satma*, standing on a hill on the right bank, Chodschan-jarni-uji by name, the velocity measured 0.74 m. in the second, while the depth was 5.8 m. To the north, and a little way back from the river, is an isolated group of poplars, belonging to the forest which is stated to lie between the Tschivilik-köl and the Kara-köl; the name given to it is Aral-toghrak, or the Poplar Island. After that poplars straggle for some distance along both banks. On the left is a sand-hill known as Janek. On the right (south) we passed a *boldschemal* amongst the reeds, and over against that we crossed a small lake-basin. Then for a short stretch the river becomes entirely lost in *jangal*. After we had passed the hill of Daulet Kismak-kurghan, firm ground became more general on both sides.

The next point we came to was Janek-baschini-arelish, where the river divides into two branches. The one on the left is that which we had hitherto navigated; the one on the right that which, increasingly augmented from lake and marsh, eventually joins the *Jätim-tarim* just above Arghan. Previously to that it is said to

pass through the Tosghak-tschantschdi, so that it is intimately interlaced with the waterway we had recently navigated.

After that there appears continuous firm ground, sand dotted over with single poplars on the right, i. e. the left bank. At Scharkurun, on the same side of the river, are three huts, deserted four years ago. Here too the river is joined by several small arms, which drain out of lakes that are either parts of the Tschivilik-köl, or off shoots from it, and which, when the river drops, form small cataracts or waterfalls (*scharkurun*). At that time, when the spring floods were at their height, the velocity was 0.958 m. in the second, so that it was tempting for our canoe-men. Then, turning south-west, and threading a series of tschapghans and small lakes, with numerous poplars showing on both sides above the reeds, we approached the village of Tägirmän, which is known to us from our February excursion. It is there that the lowest emissary of the Tschivilik-köl discharges into the Jätim-tarim; and there too, on one of the arms, stands the mill from which the village derives its name; it was then hard at work. Here we disembarked, and made our Camp No. XXXVIII.

After a little trip to the village of Schejtlar, where we had encamped in February, and where I consequently was able to connect the topographical results of both excursions, we measured the river at Tägirmän, and with the following result: breadth, 28.60 m.; mean depth, 1.593 m.; mean velocity, 0.4969 m.; and volume, 22.64 cub. m. This amount, which is thus abstracted from the llek of Kum-tscheke, is derived from Arelisch (called above Tschong-arelisch), and proceeds south through irregular windings as far as Arghan, with clumps of poplars at intervals along its banks.



Muhamed Emin, an old fisherman of Tägirmän, gave me certain information, which, as it may contribute to the elucidation of the characteristics of this complicated hydrographical region, may here be recorded. In the first place, I fell into an error in 1896, when I believed that the Kara-köl is situated between the Avullu-köl and the Tajek-köl. I now learned, that the last-named lake derives its water direct from the Avullu-köl, while the Kara-köl is said to lie to the west of the easternmost chain of lakes, being separated from it by a strip of firm ground, with dunes and tamarisk-mounds. The Kara-köl discharges into the Suji-sarik-köl. The Avullu-köl and the Tajek-köl are separated from one another by very dense kamisch-brakes, through which flows the Bos-ilek, after it has been augmented from the Tschivilik-köl. The Laschin-darja, which unites with the Kuntschekisch-tarim, discharges into the Tschivilik-köl; and during the last few years it has increased to such an

extent that there has been a general rise of level throughout the entire eastern system of waterways. The Tschivilik-köl is said to drain in three different directions. The emissary which unites with the Bos-ilek, and thus is destined to enter the Avullu-köl, is called the Kuntschekisch-sala.\* The second emissary, which proceeds to the Suji-sarik-köl, is called the Ghol-sala, or Kok-ala, and unites with the Jätim-tarim. The third emissary, the waterway we last paddled down, which likewise becomes for a short distance lost in the reeds of the Suji-sarik-köl, is called first the Ettek-sala, then the Jangi-tarim, and finally the Ilek. Hence the second emissary and the third intermingle their waters in the Suji-sarik-köl before they again separate. Properly speaking, the Ghol-sala consists, at all events it did that year, of several branches, and of these two are large, and form falls of more than one meter in height. The lower of these two branches discharges immediately above Camp No. XXXVIII, the upper one a good bit higher up, while a third branch, quite small, is the one that drives the mill of Tägirmän. All three branches issue from lakes and marshes, which are directly connected with, or rather constitute, the lowest and most southerly extensions of the Tschivilik-köl. The Jätim-tarim has its own bed from Arelisch to Arghan, and in the vicinity of this last picks up on the left (see pp. 192—193) the Jemischek-kok-ala, the beginning of which we passed on our left just below Scharkurun. This river, the Jemischek, and the branches of the Ghol-sala carry all the water that goes to Arghan; the rest of its discharge flows into the eastern waterway, and so eventually into the Karaunelik-köl, near Schirge-tschapghan. And as the Kara-köl at all events discharges into the Suji-sarik-köl, it results that not all of the discharge of the Kontsche-darja finds its way into the Tajek-köl and Arka-köl, and the Kok-ala of the latter. As a matter of fact, the Kontsche-darja by no means forms a hydrographical system to itself, but is distributed, and mingles with the water of the Tarim. How far the circumstances in 1896 were the same as they were in 1900 it would be difficult to say. One thing at any rate is certain, namely that in the former year the Laschin-darja was nothing like so big as it was in the latter. By my journey of 1896 I determined the whole eastern boundary of the Tarim delta, and proved that no water proceeds farther to the east. On this present occasion I was in the heart of the watery labyrinth, which I succeeded in disentangling, though it was a trying and wearisome task. Nor should I be one bit surprised to learn that the distribution of the water in that delta is now at the time of writing (1904) different from what it was in 1900.

My informant then went on to tell me, that he had come to Schejtlar and Tägirmän 24 years before in quest of fresh pasture-grounds. What he was in search of he indeed found, but there was no water; and it was not until two years had passed, or about 1878, that the water began to make its appearance there. Shortly before it did so, the depression of the Tschivilik-köl became filled, and simultaneously with this the Jätim-tarim originated at Arelisch in a district which had hitherto borne no name. In the autumn of 1896 the Tschivilik-köl had risen a great deal in consequence of the very considerable increase in the volume of the Laschin-darja. Nevertheless the level had never been higher than it was in 1900; it had

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\* The word *sala* means in this locality »river-arm».

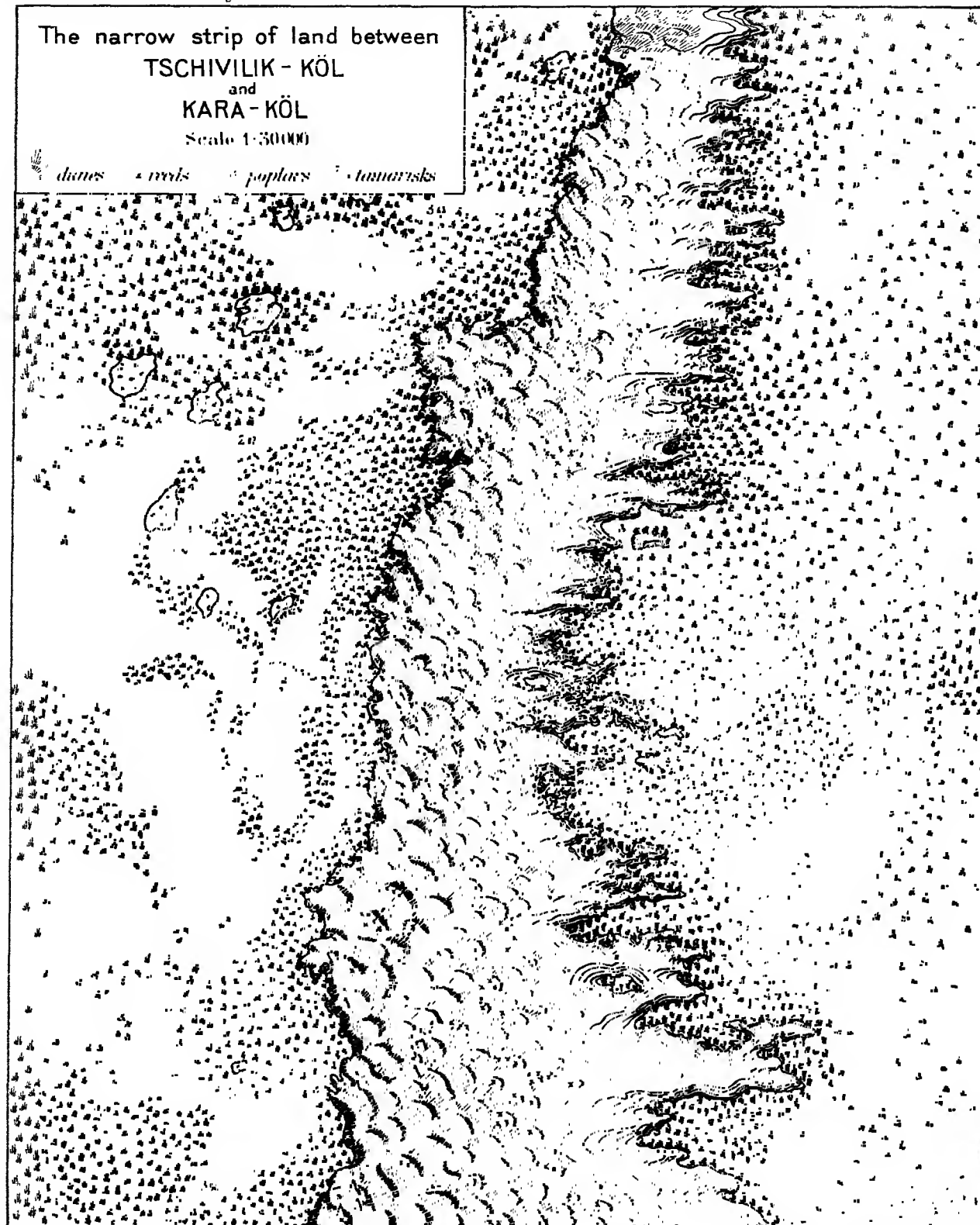
not risen so high even at the high-water period of the preceding autumn, for under ordinary circumstances the autumn flood is wont to be considerably bigger than that of the spring (*mus-suji*). In spite however of the expansion of the *Tschivilik-köl*, complaints were rife that the fishing is deteriorating, because the lake threatens to be encroached upon to such a serious extent by the *kamisch*.

The *Jätim-tarim* had already begun to subside; and in two months it would be *kuruk* (dry), that is without current, though pools survive in its bed all summer. In this condition it remains for fully two months, then in the end of August, or beginning of September, a fresh flood comes down. During the winter the level drops again considerably, as we have seen, for instance, during the past February, when the ice-sheet sagged in the middle. All these statements confirm the opinion I had already formed, that the meridional portion of the lower Tarim has begun to turn back again towards the east. And if any doubt on the point remains, it will be instantly removed, when we call to mind the presence of the dry river-bed, the *Ettek-tarim*, on the west, and the new channel, the *Jangi-tarim*, on the east.

Using the *Tägirmän* of *Schejtlar* as a base for our operations, we spent the 28th April in making two or three excursions in the neighbourhood. First I got Muhamed Emin and another fisherman to paddle me to the hut of *Scharkurun* on the *Ettek-sala*, the real beginning of the *Ilek*, and from there I went over on foot to the *Kara-köl*. The distance measured 4145 m. — 5554 paces in going and 5551 paces in returning — so that this method of counting one's paces does give pretty reliable results. The strip of land between the *Ilek* and the western shore of the lake we crossed in a north-easterly direction. It is divisible into three zones. (1) A western, with scattered *toghraks* of medium age, *kamisch*, living tamarisks, tamarisk-mounds, little pools of salt water; in four of the deepest places the water came bubbling out of the ground without having any surface connection with the water at the side. (2) The middle zone is *tschöl*, or »desert», with dunes of respectable size, their steep faces being in every case turned towards the south-west, dead tamarisks on high mounds more or less linked together by ridges of sand, dead *kamisch* in places, and in one or two spots level *schor* ground, showing that here there was once a sheet of water. (3) In the eastern zone the dunes grow lower, and finally give place to *kamisch*-fields, which become thicker as the lake is approached; then come two or three marshy arms, and finally the lake itself, with dense *kamisch* and small sheets of open water. Not far from the shore stands the *satma*, *Kara-köldeki-satmasi*, in which Muhamed Emin took refuge with his family and live-stock when the last *Tunghan* revolt threatened to extend through East Turkestan; but as soon as the danger was over, he returned to *Schejtlar*.

The weather was anything but favourable for a reconnaissance, for a *kara-buran* from the north-east, which set in about 1 a. m., continued to blow all day. It was full twilight, and objects which were quite close at hand appeared like shadows, or as if they were looked at through muddy water. The sky moreover was thickly clouded; the driving dust penetrated everywhere, so that in the morning every object in the tent was smothered with it. Under these circumstances our lake excursion was somewhat risky, the gunwales being only one decimeter above the water, and as the waves were  $1\frac{1}{2}$  dm. high, it was not long before our canoes





*Drawn by Dr. Sven Hedin.*



were like baths. We managed however to keep afloat by clinging to the shelter of the kamisch, and in that way made a circuit of the open part of the lake; this however, in comparison with the reed-free basins of the Arka-köl and the Tajek-köl, is of very small area. In fact, this lake, the Kara-köl, is considered to be the same size as the Tschivilik-köl, the only difference being that the former is for the most part overgrown with kamisch. The marshes and areas of open water which, on the strength of insufficient *data* I in 1896 took to be the Tschivilik-köl, belong in reality to the Kara-köl. This lake is tolerably deep — 4.30, 5.65, and 6.52 m. — and we neither discovered shallow places nor observed islets of tamarisk-mounds

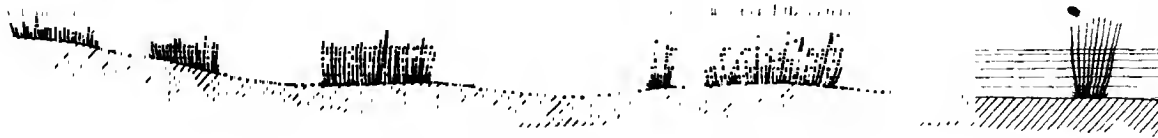


Fig. 426. SCATTERED KAMISCH IN THE OPEN PARTS OF KARA-KÖL.

projecting anywhere above the surface. On the other hand, the reeds frequently grow in 2 to 3 m. depth of water, and stick up in clumps and sheaves. This great mass of kamisch extends southwards until it comes into contact with the kamisch-beds of the Suji-sarik-köl; were it not for this obstacle one would be able to paddle out of the one lake into the other. In fact, the two really constitute but one lake, the only division between them being the kamisch, and their difference of name. The word *köl* means in general those parts only into which canoes are able to penetrate, and fishing and egg-collecting can be carried on. On the east the Kara-köl is separated from the northern part of the Tajek-köl by a strip of land.



WEST

Fig. 427. THE ILEK A LITTLE BELOW SCHARKURUN.

EAST

In the clear water of the Kara-köl I made an interesting observation. The roots of the kamisch and various parts of decaying vegetation, mingled with clay, ooze, and mud from the bottom, become matted and stuck together in pretty big cakes, which partly swim on the surface, partly float just underneath it, and sometimes are so large that they appear capable of supporting the weight of a man. These the natives call *sim*. Thus in these marshes and lakes there is taking place unceasingly a not inconsiderable formation of turf. Hydrographically this *sim* plays of course an important part. As the result of decomposition, gas is developed; this causes the *sim* to rise to the surface, and so great is their power of transportation that they even bring with them clay, mud, sand, and other material that have settled

at the bottom of the lake. As they naturally travel with the current, they of course gradually close up the mouths of the drainage channels, and thus act as natural sluices, raising the level of the lake. Hence they afford an eloquent proof of the proposition, that it is the decaying vegetation which in an essential degree helps to fill up the depressions.

On our way back we measured the volume of the Ettek-sala or Ilek at Schar-kurun, where the river gave the accompanying section and yielded the following measurements: breadth, 29.15 m.; mean depth, 3.081 m.; mean velocity, 0.4243 m., and volume, 38.11 cub.m. Of this large amount there was left in the Ilek at Camp No. XXXV on 25th April only 21.98 cub.m., so that, disregarding any oscillations of level which may have taken place in the interval, there was a loss of 16 cub.m. in this short distance. Of this loss the greater part consisted of water which went to augment the Jemischek-kok-ala that unites with the Jätim-tarim at Arghan; while the residue is absorbed by the marginal lakes and marshes situated on the right side of this same waterway. At all events, the Ilek of Kum-tscheke derives its water partly from the Ettek-sala, and partly from the Kara-köl *via* the Suji-sarik-köl, though in what proportion from each it is impossible to say: in both cases alike it is derived ultimately from the Tschivilik-köl plus the Bos-ilek (see below). Thus the water of the Ettek-sala is discharged along two main arteries — the Ilek and the Jemischek. Its volume constituted one-half of that of the Tarim at Kirtschin on the 23rd May; but Muhamed Emin was of opinion, that within a few years the entire volume of the Tarim would flow this way, unless in the meantime the authorities prevent it by constructing huge dams at appropriate places.

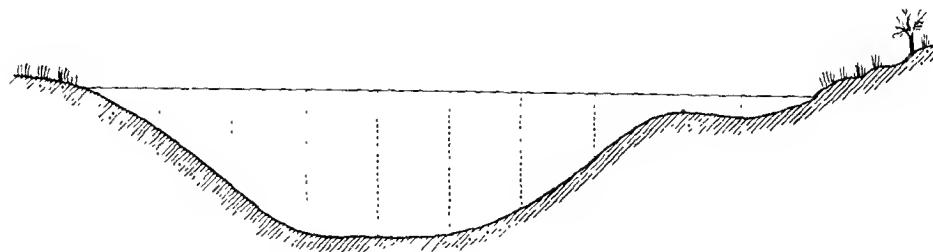


Fig. 428.	Right.	1.55	3.90	5.54	5.73	5.56	4.39	2.42	0.71	0.96	= depth.	Left.
		52	55	51	51	42	39	40	3	1	} velocity.	
		60	66	63	57	46	48	61				
		36	58	72	58	60	18	12				
			4	62	57	51	3					
				53	68	42						

Breadth = 29.15 m. The Ettek-sala at Scharkurun; April 28. Scale = 1 : 300.

On the afternoon of the same day I made a little trip by canoe on the Jätim-tarim to the upper kok-ala that issues from the Tschivilik-köl. These two kok-alas bear a striking resemblance to the two arms at Schirge-tschapghan. In both cases alike the emissaries issue from extensions of the lake, and spread out like the fingers of a man's hand, each forming at first a narrow, well-marked trench, which widens out in the middle into an elongated lake with an imperceptible current, and finally, after contracting again into a deep, narrow trough, plunges over a cataract. The lower kok-ala of Tägirmän forms however an exception in respect of this last-

mentioned feature: there is no cataract at its entry into the Jätim-tarim. The water in these kok-alas is perfectly clear. And so potential is the outpour of the upper kok-ala that, even at a distance of a couple of hundred meters below the confluence, it thrusts to one side the muddy water of the Jätim-tarim, until the latter forms a narrow ribbon of grey close along the right bank. This emissary is however the most powerful of the arms of the Tschivilik-köl which here enter the river. Just below it the Jätim-tarim is divided into two branches, of which the smaller is on the right. In front of the middle kok-ala a small sedimentary island has formed, and on it the kamisch has already begun to establish itself. The banks of the upper canal are adorned with tolerably vigorous forest, estimated to be 60 to 70 years old, the poplars being almost as advanced in age as those of Schirge-tschapghan. This forest already existed when Muhamed Emin came into this part of the country, and he was of opinion that it had altered but little in appearance since he arrived. The toghraks of the Jätim-tarim have on the other hand shot up since he did come; their age he estimated at 15 years; they are 8 to 10 m. high and slender, and stand close together.

It is only below the upper kok-ala that the river assumes a more imposing appearance, and this becomes still more accentuated after it has been joined by the others. Above them it is however unimportant, and this is said to be the reason, coupled with its insignificant current, that it is called the Jätim-tarim, which properly means »fatherless and motherless», as much as to say, it is deserted, helpless, awkward. To avoid the trouble of measuring all these different canals, I measured instead the Jätim-tarim above them, with the following result: breadth, 24.61 m.; mean depth, 1.348 m.; mean velocity, 0.1456 m.; and volume, 4.83 cub.m. in the second. The day before we had obtained below these same canals a volume of 22.64 cub.m.; so that the amount contributed to the river through these kok-alas amounts to not less than about 18 cub.m., all of which issues out of the Tschivilik-köl, and by this route makes its way to Arghan. The conformation of the bed of the Jätim-tarim both above and below the kok-alas is approximately the same, but above them the current is excessively slow. The cataract in the lowest kok-ala makes a descent of 1.68 m.; that of the middle kok-ala descends by three steps, respectively 0.40, 0.50, and 0.34 m. high, or 1.24 m. in all. The difference of 0.42 m. is distributed over the slopes which stretch above and between the actual »thresholds». The uppermost kok-ala makes a fall of only 0.40 m., though for a considerable distance below it there are broken rapids.

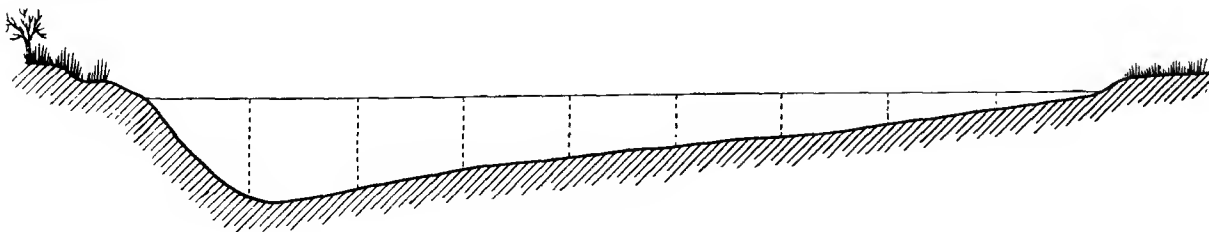


Fig. 429.	Right.	2.63	2.30	1.86	1.60	1.33	1.12	0.81	0.48.	Left.
		18	24	22	18	18	7	1	0	
		19	27	24	22	19	5	1		
		22	19	20	18	7	3			
		10	11							

Breadth = 24.61. The Jätim-tarim above the channels from Tschivilik-köl; April 28. Scale = 1 : 200.

Recapitulating the main features of the hydrography of this region — the Kuntschekisch-sala, or Eastern River-arm, enters the Tajek-köl *via* the Bos-ilek and Avullu-köl; the Ghol-sala, or the Middle River-arm, because it is situated between the others, enters the Kara-köl; and the Ettek-sala, or the Western River-arm, flows to the Ilek *via* Scharkurun and the Suji-sarik-köl, or the Yellow Water Lake, so named because its bottom is free from sand. Thus, whilst the Tarim has a slow and regular fall, there occur in the eastern waterway, in two places, »thresholds» with waterfalls, and these will only disappear when the lakes have been filled and levelled up.

On the 29th April we returned across the small lakes and tschapghans to the Ettek-sala, and after crossing it plunged once more amongst the tschapghans. The first lake we came to was the Tajir-kirgen. On the left was an island with poplars on it. Our course was towards the north-north-west, with the belt of sand on the right. The next lake, Kemi-tapdi, was larger; it was followed by the Ghun-ilek, with a distinctly perceptible current. Here we obtained depths of 4.87 and 3.50 m. At one point, where the water converges south-west into the upper kok-ala of the Jätim-tarim we sounded depths of 3.12 and 4.0 m. Then we again had an *ilek*, with a velocity of 0.65 m. in the second; thus this canal, although flowing through reeds and bordered on both sides by marshes belonging to the Tschivilik-köl, had a pretty swift current. Every now and again there were on the right islands with toghraks; these last did not appear to be thriving in the superabundance of water. The depth amounted to 3.60 m. The firm, sandy shore of the Tschivilik-köl was visible a short way off to the east. The Kara-köl lay south-east and east-south-east. Then we emerged upon the Tschivilik-köl, where there are bigger open sheets of water. The strip of land which separates this lake from the Kara-köl narrows towards the north (Pl. 55). We obtained depths of 4.64, 3.90, 4.10, and 4.40 m.; this lake appears to be remarkably uniform in its depth, though it should also be stated that our course along it lay at an equal distance from the eastern shore, where the elevation of the dunes, their slope, and the relations of the wind were everywhere the same. Here was a tiny fishing-station of 2 ujlik (8 persons) called simply Tschivilik, the name that is applied to the lake as a whole. The tamarisk-mounds which here dot the shore consist almost entirely of sand, and are crowned by living tamarisks; it is evident they have been formed directly by the sand-dunes, and these again are in part held together and deformed by them. This occurs at the spot where the strip of land between the Tschivilik-köl and the Kara-köl is narrowest, the kamisch of the latter being visible at less than one kilometer's distance. S. 80° E. there is, a long way off, an open sheet of water. The dunes and tamarisk-mounds of this isthmus are highest in the west, their altitude decreasing as the shore of the Kara-köl is approached; this lake sends out amongst the reeds long tapering polyp-arms, with islands at their extremity. The shore-line of the Tschivilik-köl runs N. 10° W. Viewed from the isthmus just mentioned, the lake appears to have its longest extension towards the N. 75° W., but its western shore was lost in the distant haze.

Continuing towards the north-west, we obtained soundings of 4.20, 4.14, 4.67, 4.19, 2.67, 5.00, 4.80, 5.15, 3.62, and 2.66 m., the lake being here again of pretty uniform depth. On the way we passed a good many small islands encircled by reeds, with

poplars on them; one of these bore the common name of Kök-toghrak. On the left lay Kasan-käti-köl. Then we turned to the north-east. We now had no difficulty in getting along, there being no narrow tschapghans to hinder us. And yet these open sheets of water were not particularly great, for, as is usually the case, the kamisch occupies the greater part of their area. We encamped at Kadike, one of the larger temporary settlements in the Lop region, a place of 10 ujlik, with respectively 4, 6, 5, 3, 4, 5, 3, 3, 4, and 3 inhabitants, or 40 in all, giving an average of 4 persons to each household. But at that time only the oldest and the youngest members of the settlement were at home; those who were capable of work were at Jangi-köl tilling the ground. In winter all these families dwell at the mähallä of Jangi-su. All the fishing settlements we passed between Tosghak-tschantshdi and Soghot are subject to the bek of Jangi-su. Scattered over the district are 42 ujlik, and to them must be added 25 ujlik at Jangi-su itself and one ujlik at At-jegen on the Jätim-tarim. The *beklik*, or »administrative district», of Jangi-su is considered to number 498 people in all. Its southern boundary runs through Arghamtschi-baghlaghan immediately south of Arghan, and its northern through the following points — Modschuk-kotan, Jalghus-toghrak (between the Kuntschekisch-tarim and the Tschong-tarim), Tajir-tschapghan (on the left bank of the Laschin-darja), and Ägir-asti on the right bank of the Tarim.

From Kadike I next made a little trip to the Avullu-köl, the result of which was not only to clear up to a great extent the intricacy of this complicated eastern system, but also to confirm observations which I had previously made, as well as to corroborate the information which I had received. After crossing the lake to the north-east, we paddled along the Kadike-ilek; this, after picking up on its left the ilek of Mandschar-baschi, unites with the Bos-ilek (Ördek-jaghutsch-ilek; Kontschedarja), and then our course ran due south. Thus the Avullu-köl lies almost due east of the Tschivilik-köl. The stream was by this a pretty considerable river, with a powerful current and deep clear water; but it was for the most part bordered with reeds on both sides. Soon however toghrak forests appeared, sparsely on the right, but luxuriant, and situated amongst sand-hills on the left. All along the river sheds off numerous small canals, some of which soon return to it again, while others go their own ways until they empty into the Avullu-köl or the Kara-köl. At length our direction became more easterly; on the right we passed a large arm which proceeds direct to the lake last mentioned. Finally the river, splitting into innumerable branches amongst the reeds, in this way empties itself into the Avullu-köl, with a velocity which amounted to 0.84 m. in the second. Before we reached moderately open water we had a hard struggle to get through the kamish and jākän; this lake presents the same marshy appearance as its neighbours. The depths we measured were 2.25, 2.82, 3.90, 4.54, and 6.10 m.; this last is said to be the maximum depth in this lake. When we were unable to advance any farther owing to the kamisch, we turned back; it was at a point whence we could see, in the north and N. 35° E., the poplars that stand beside the route I followed in 1896. The nearest were about 1½ km. distant, and the whole of the intervening space was occupied by kamisch. The stream quits the lake in two arms. Of these the left one is said to issue to the east of the point where we turned back, and to proceed to the ad-

jacent Tajek-köl; the other, on the right, goes south-east, and enters the Kara-köl. Here then I had confirmation of the statement, that the Tajek-köl and the Kara-köl form two distinct lakes, and that the latter is interposed between the system of the Tajek-köl and that of the Tschivilik-köl. The natives aver, that the branches which issue from the Avullu-köl are equally as big; but this it must be impossible to determine, for they do not flow in well-marked channels, but are dispersed amongst the kamisch. Unfortunately there existed no means of paddling down either to the Tajek-köl or to the Kara-köl. At all events this last is fed from two different directions, in part from the Avullu-köl, in part from the branch which I have mentioned above as being on our right, and which does not touch the Avullu-köl. And no doubt there are numerous other arms besides these filtering their way through the kamisch and the marshes; these it is impossible to control. The open part of the other branch that proceeds direct to the Kara-köl had the following dimensions — breadth, 11.0 m.; mean depth, 1.438 m.; mean velocity, 0.4395 m.; and volume, 6.95 cub.m. in the second. This is however too small, for a portion of the channel is hidden amongst the thick reeds. This water flows direct into the Kara-köl, the Suji-sarik-köl, and so on southwards.

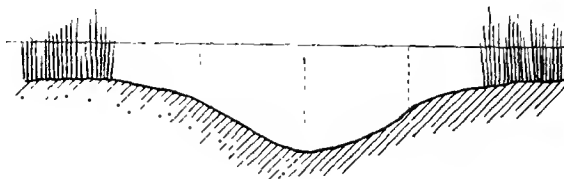


Fig. 430.    1.40    2.75    1.60 = depth.  
                  42    53    42 velocity.  
 Breadth = 11.0 m. The channel to Kara-köl; April 29. Scale = 1 : 200.

Here again the people declared, that the water that year had risen higher than it had ever done before, and this they attributed to the rise of the Laschindarja. Others of the natives maintained that the Bos-ilek had risen to the same extent; but that may be only a delusion, due to the fact that when a rise takes place in the Tschivilik-köl, it is wont to be propagated up the Bos-ilek, so that this latter does appear to rise. One old man told me, that he came to Kadike 28 years before, and that there had been water there then for 8 years; or in other words the first time water appeared at Kadike was 36 years ago. Previous to that the country was *tschöl*, or »desert», while the Bos-ilek flowed into the Jätim-tarim, discharging by a channel where the kok-alas of Tägirmän are now situated. It is not always quite easy to reconcile the different statements one receives from the natives. They sometimes refer to different parts of the same district, and may be individually correct, even when they do appear to contradict one another. But something must also no doubt be set down to lapses of memory on the part of those who give the information.



## CHAPTER XXX.

### THE KUNTSCHKEKISCH-TARIM AND ITS CONNECTIONS WITH THE KONTSCHE-DARJA.

The 30th April was spent in making a reconnaissance up the lowest course of the Bos-ilek, my object being to obtain some idea of its bed in that part, for in 1896 I had already travelled a little way along its banks. These are now masked by impenetrable kamisch and thickets, interspersed at intervals with groves of luxuriant toghraks, cumbered with a tangle of climbing plants and fallen and broken branches. Just inside (east of) this vegetation runs the track I followed in 1896. During this part of its course the Bos-ilek is joined by five small, narrow kok-alas from the Tschivilik-köl, none of them carrying much water. The river flowed sluggishly, but the water was bright and clear, transparent to a depth of 6.12 m. No doubt it would be transparent to a greater depth if only greater depths existed, and were it not that the bottom is dark owing to the shade of the vegetation on its banks. In this part the river is never fordable at any time of the year, except on certain shallow transverse ridges or thresholds above the district of Talashti. Tigers, wild boar, antelopes, foxes, and hares abound in this locality.



Fig. 431. SCENERY OF THE LOWER BOS-ILEK.

After the Ilek has collected itself together, that is above the point where it sends off its arms to the Kara-köl and Avullu-köl, and below the point where it receives the overflow of the Tschivilik-köl, *plus* the Bos-ilek, I took measurements of it, with the following results: breadth, 19.9 m.; mean depth, 2.203 m.; mean velocity, 0.9080 m.; and volume, 39.80 cub.m. in the second. The greatest velocity in this section occurs at a depth of 1.5 m. from the surface. On both sides of the river are extensive marshes, which, although they are in constant and uninterrupted communication with it, nevertheless contain stagnant water. It is possible that under the right bank there may be one or more small channels creeping through the kamisch, but these we could not for that reason get at; if so, their volumes ought to be added to the total I have just given above.

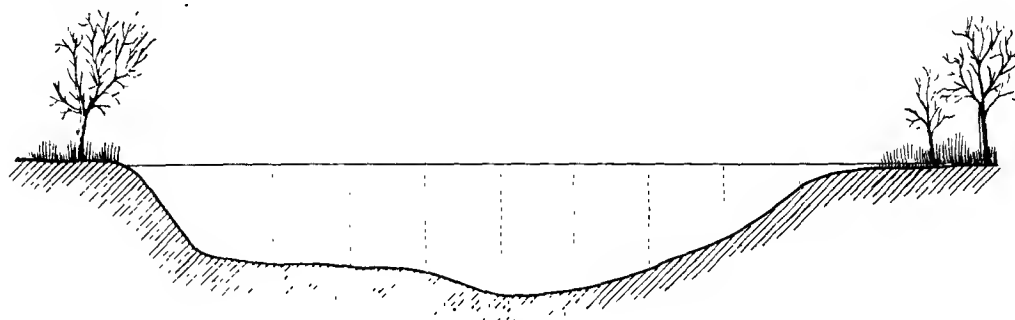


Fig. 432.	2.35	2.55	2.58	2.86	3.43	3.23	2.64	1.91	0.45	= depth.
	95	108	109	114	109	108	109	90	11	} velocity.
	120	119	112	117	111	119	115	90		
	130	120	113	112	110	110	105	73		
	125	118	85	111	106	92	99	44		
	112	117	78	99	91	90	82			

Breadth = 19.9 m. The Bos-ilek a little above Avullu-köl; April 30. Scale = 1 : 200.

After that we measured the Bos-ilek above all the little kok-alas which it receives from the Tschivilik-köl, the measurement being taken at the end of the excursion so as to ensure that we included none of the water from the lake in question, for the direct overflow would hardly be likely to advance so far up. The breadth was 20.22 m.; the mean depth, 2.631 m.; the mean velocity, 0.2485 m.; and the volume, 13.22 cub.m. in the second. On the 1st April 1896, two days' journey higher up,

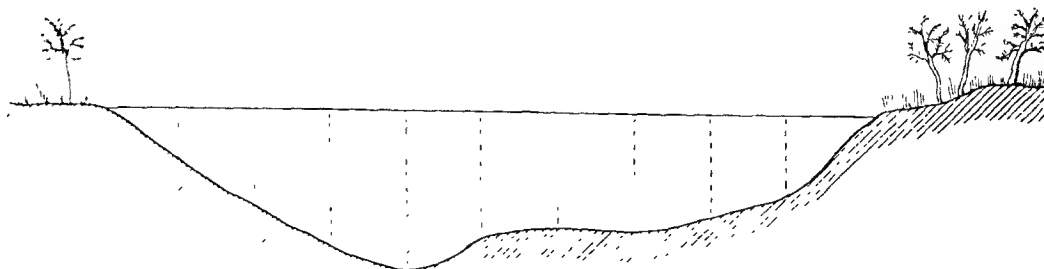


Fig. 433.	Right.	1.44	2.51	3.62	4.35	3.39	3.03	3.11	2.79	2.05	= depth.	Left.
		10	20	30	40	37	32	24	30	9	} velocity.	
			26	37	35	31	33	32	16			
			13	28	36	31	30	18				
					33							

Breadth = 20.22 m. Bos-ilek above the branches from Tschivilik-köl; April 20. Scale = 1 : 200.

this same river gave a volume of 12.12 cub.m. Thus on the last day of April 1900 its volume was 1.1 cub.m. more; now this is the opposite of what one would have expected, not only because the river carries a greater amount of water in the beginning of April, when the freshets from the melting ice are coming down, but also because of the loss occasioned by evaporation and absorption on its way down to the Avullu-köl. Whereas we find that not only had the river not decreased along this stretch, but it had actually increased. The only explanation can be, that the branches of the Kontsche-darja, which feed the Kuntschekisch-tarim, had diminished. Thus the Kontsche-darja manifests the same tendency as the Tarim to shift its channel back towards the east.

Upon subtracting the volume of the Kontsche-darja water (13.22 cub.m.) from the immediately preceding measurement, we obtain a residue of 26.58 cub.m., the amount of the discharge from the Tschivilik-köl in this direction. Add to this the Scharkurun water, 38.11 cub.m., and the total (17.81 cub.m.) of the canals that empty themselves into the Jätim-tarim, and we get a grand total of 82.5 cub.m. for the combined discharge from this lake in the three different directions. This is only 3.4 cub.m. less than the total volume of the Tarim at Jurt-tschapghan (on 13th April), but three times as much as flowed past Kum-tschapghan to the Kara-koschun on 10th April. Excluding from the total just given the volume of 17.81 cub.m. which enters the Jätim-tarim, the 15 cub.m. belonging to the arm that begins just below Scharkurun, and under the name of the Jemischek likewise enters the Jätim-tarim just above Arghan, and the 5.15 cub.m. which flows into the Tarim through the kok-alas of Schirge-tschapghan, or in all 38 cub.m., then the remainder, or 44.5 cub.m., must be ascribed to the eastern waterway, *viâ* the Karaunelik-köl and the Tokus-tarim, notwithstanding the rapidity with which we have seen that the water is dissipated, and decreases, on the way down, so that, for example, there only remained 9.41 cub.m. in the Tokus-tarim on 16th April, and even a good deal of that was lost before it reached the Kara-koschun. The dissipation and loss are naturally greater in consequence of the water seeking its way through these numerous channels than they would be if it flowed along one definite, fixed main artery. Hence the multiplication of the arms of the Tarim delta is a contributing cause of the diminution of the Kara-koschun. Were the waters to become concentrated into one channel, it would be tantamount to an augmentation of the terminal basin. In all probability the old Lop-nor was greater than the existing Kara-koschun, and one of the causes of this was that it received its main influx through a single channel. One consequence of the many arms into which the river now divides is that the levelling of the surface is more evenly distributed over a wider area.

Leaving Kadike, a district which in its entirety is also known as Mandscharbaschi, we on 1st May, with fresh canoes and a fresh set of canoe-men, proceeded west-south-west across the lake of Tschivilik-köl. On this side too it possesses several extensive reaches of open water, which lend themselves excellently well to navigation by canoe. Nevertheless complaints were general that the reeds are threatening to encroach upon it. Occasionally we passed an island bearing toghraks and tamarisk-mounds. The soundings gave depths of 2.36, 4.13, 4.00, and 5.10 m.; but there were no such shallow places here as we found in the Kara-koschun. The farther

we advanced the muddier grew the water. In the lower parts of the lake it was perfectly clear, but in proportion as we penetrated the channel, which grew more and more distinctly marked, the transparency decreased, first to 0.63 and then to 0.39 m., and when we entered the Tarim-tüschken-köl, or the Lake of the Discharging River, we again encountered the muddy stream. South of this lake extends a large sheet of open water, and beyond it, in the far distance, rises a lofty mound from the top of which »a Russian *tura*», probably Kosloff, is said to have viewed the lake. On the right we passed the Kasan-käti-köl. Gradually the lake merged into the lower part of the river, forming a sort of delta, just as the Ileik does in the Avullu-köl, in that it cuts broad passages through the kamisch and sedimentary deposits, while at the same time the mud-banks grow more numerous. Immediately below this mud-delta the velocity amounted to 0.65 m. The Kara-koschun however, contrary to most of the northern lakes, or rather to the first lake-link in each chain of such, does not possess any similar mud-delta, or at the most has only the rudimentary indications of one. Thus the water would appear to be relatively clearer at its entry into the Kara-koschun than it is when it enters each of the more northerly lakes. On the left bank, at the spot where the river enters the lake, stand some huts known simply as Kona-satma; these were occupied some ten or twelve years ago by the people of Kadike for two summers, before they flitted to their present abodes.

After that we travelled south-west along the lower part of the river, having dense reed-brakes on both sides of us. From the left bank issued two branches, which entered the lake of Kasan-käti west of Kona-satma. Then we turned west, and had on the south At-jegen, and on the north an extensive area of low sand, with tamarisk-mounds; and these features continued all the way to the Bos-ilek, which was half a day's journey distant from that point. A little way off there were both dead and living poplars. On the right Kara-daj, and soon afterwards a shepherd's hut; and all the way up to the *tschong-jol*, or »great highway», the river is accompanied by kamisch and tamarisks. Although the stream is not especially winding, nevertheless such bends as there are, conjoined with the current, tended to retard our progress.

Next we came to the point, Arelisch, where the Jätim-tarim divides, and which we passed through on our preceding excursion (see p. 424). The attention is at once arrested by the fact, that quite suddenly the forest becomes especially luxuriant above the bifurcation, or what amounts to the same thing, the Kuntschekisch-tarim below Arelisch is a relatively new stream. I was also told by the guides who were then accompanying me, that the whole of the Tarim used formerly to flow through the bed of the Jätim-tarim to Arghan; and even middle-aged men were able to recall the time when the branch which enters the Tschivilik-köl was formed. When that took place, the current was so strong that it was impossible to paddle against it, and communication had to be maintained by means of a couple of side-canals. Two or three such side-arms still survive.

Judging from distinct marks the big river, the Kuntschekisch-tarim, had recently fallen 18 cm. It has thick and magnificent forests on both banks. On the left there is here a boldschemal which was abandoned two years ago; it was full of water

when we passed, and looked like a river bay. This place, Dargh-ilek, is also interesting for another reason; it possesses the ruins of about a score of huts, to which during the Chinese supremacy, previous to Jakub Bek's time, the beks of Turfan used to come, *viâ* Turfan-köbrük and the Bos-ilek, to collect tribute from the inhabitants of Kara-koschun and Laj-su. The tribute, which consisted of 9 otter-skins (*kama*, *kamar*), was no doubt a symbol of these people's subjection to the Chinese at Turfan. These tribute-levying beks are stated to have brought with them supplies of flour, which they presented to the native beks for distribution amongst the people, and as at that time agriculture was not carried on in these regions it was a most welcome gift. Accordingly the people streamed together in their canoes from all parts to this improvised market at Dargh-ilek. The oldest of these Turfan beks whom the people remembered was Murat Baki Bek, who lived at least sixty years ago. He was followed by Sarki Bek and Ahmet Bek; my guide, Kirghuj Pavan remembered the journeys of the last-named forty years back. The last two beks used also to visit Tikenlik on a similar errand. The practice died of course a natural death when Jakub Bek conquered East Turkestan.

In this region the river scenery is grand and imposing, the forests being abundant and well-grown, the scarped banks high, the river deep and well defined, and the windings not dangerous; the banks are silent and peaceful, there being neither human beings on them nor their dwellings. On the right we passed the abandoned boldschemal of Kisil-su, containing, as the name indicates, bitter water; opposite to it is a mill. After passing the confluence of the Kuntschekisch-tarim and the Laschin-darja, we encamped on the right bank of the former, near the huts of Muhamed Tokta at Säkitma. At this time the inhabitants consisted of 10 persons, forming one ujlik, or household; they support themselves by agriculture and breeding sheep, but do not carry on fishing. The general name for the district is Dilgi, from Dilgi Baj, the father of Muhamed Tokta; Säkitma is the name of the huts only. The river is here called the Kontsche-darja, and at that season almost all the water that flowed along it was derived from the Hädik-ghol and the Baghrasch-köl; for the bed of the Kuntschekisch-tarim above Gendeng is practically dry, the only inflow into it being through a dug arik which begins at Kirtschin and enters it after irrigating the fields of Tikenlik. The Kuntschekisch-tarim drops during the summer about 60 cm. at Säkitma, so that its fall is a good deal less than that of the other streams, which are reported to fall one kulatsch (1.7 m.), but then the more constant flow of the Kontsche-darja has also to be taken into account. This last does of course rise in the autumn, but is highest in the spring; being in this respect contrary to the Tarim and its ramifications, in which the high-water season occurs in September and October. In the Kontsche-darja the formation of the ice and its subsequent break up are the principal causes of fluctuation, all the other changes being regulated by the Baghrasch-köl.

At this place I gleaned the following information. Our river was at that season dropping every day. The Tschivilik-köl would maintain its then level for yet another month, but during the two following months it would drop. In the autumn it rises, at first slowly, then swiftly, until it reaches its maximum for the year, exactly at the same time that the Tarim reaches its autumn maximum. Then

the lake freezes, its level being at all events as high as it was then in the beginning of May; but whilst frozen it drops about 2 *karätsch* (= 0.45 m.). Then, when the ice has broken up, the level rises to what it was just then, the volume being of course augmented by the *mus-suji*, called in this locality also *sarik-su*, or the »yellow water«. Muhamed Tokta's father came to Säkitma when 16 years old, and lived there all his life, dying in 1897 at the age of 90. When he arrived there in 1823, there were only two rivers, namely the Big Tarim, flowing along its westernmost bed, and the Kuntschekisch-tarim. Previous to his time, or about 100 years ago, the Tarim used to flow through the bed of the Laschin-darja. Afterwards this was dry for a pretty long period, and it was only  $3\frac{1}{2}$  years before my visit that the water returned to its channel, while in the actual year of my visit it had assumed imposing dimensions.

During the course of the day we measured the river twice; first, just below the point where the Jätim-tarim leaves the Kuntschekisch-tarim, and makes at first, apparently for no reason, a big curve towards the north. Here the breadth was 11.98 m.; the mean depth, 1.215 m.; the mean velocity, 0.5221 m.; and the volume, 7.60 cub.m. in the second. At Schejtlar on 28th April the volume was 4.83 cub.m.; thus in that short distance the river had lost very nearly 3 cub.m., and yet it was falling daily, indeed during the 36 hours of our stay at Schejtlar it dropped 4 cm. Possibly the explanation is to be sought in side-arms of which we have no knowledge.

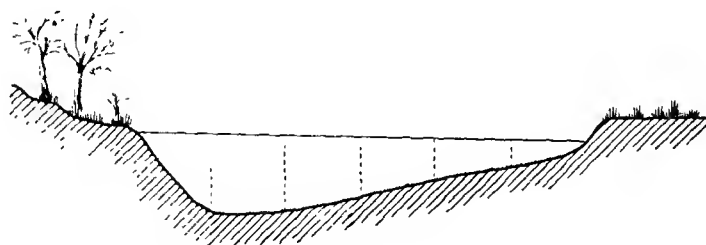
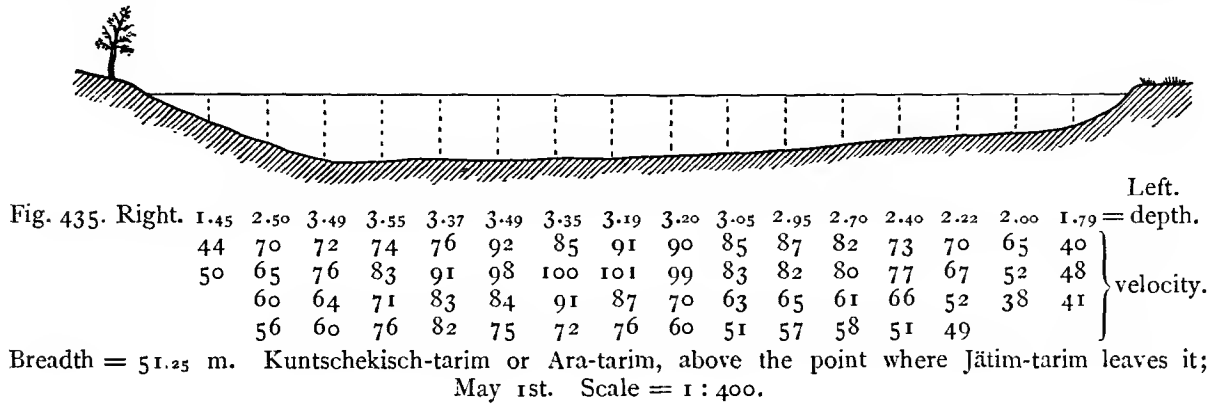


Fig. 434. Right. 2.02 1.95 1.54 1.08 0.70 = depth. Left.  
 42 60 60 60 58  
 53 58 62 56 37 } velocity.  
 58 61

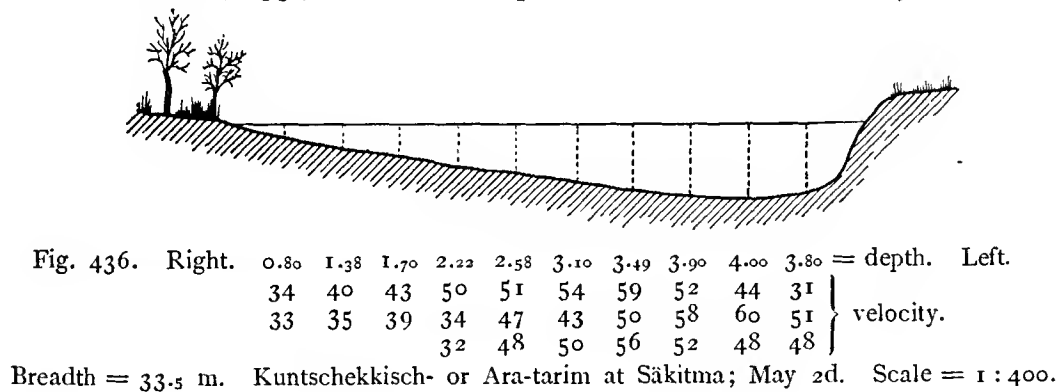
Breadth = 11.98 m. Jätim-tarim a little below the point where it leaves the Kuntschekisch-tarim;  
 May 1st. Scale = 1 : 200.

The second measurement was taken above the point where the Jätim-tarim breaks away from the Kuntschekisch-tarim, the results being as follows: breadth, 51.25 m.; mean depth, 2.629 m.; mean velocity, 0.6739 m.; volume, 90.81 cub.m. in the second. Deducting from this the volume of the Jätim-tarim, there is left a volume of 83.2 cub.m., which flows into the Tschivilik-köl. On the day before we found that the volume *out* of the same lake amounted to 82.5 cub.m. One would have expected this last *datum* to be a good deal less, for there is always a certain amount of wastage in a lake due to absorption and evaporation. And yet this circumstance, at first sight so strange, that almost as big a volume flows out of the lake as flows into it, admits of a perfectly natural explanation, and was even accounted for in a satisfactory manner by the natives themselves. The river entering

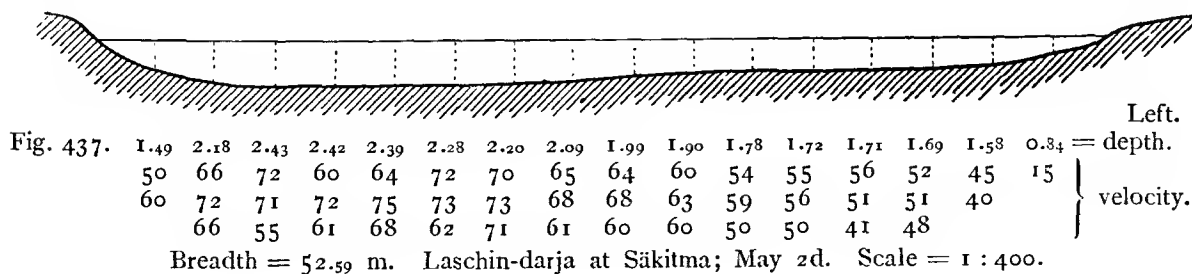
the lake had been dropping for a week (total fall, 14.8 cm.); but the lake, which acts as a distributor of the masses of water, was still full and even enlarged, being still at its maximum; for this reason the natives did not look for any appreciable diminution in the rivers draining out of it until another month had passed; but when that time came, the Laschin-darja would be very low. However, above the Jätim-tarim the Kuntschekisch-tarim is only exceeded in magnitude by the united Tschong-tarim.



On the 2nd May the Kuntschekisch-tarim gave at Säkitma the following dimensions: breadth, 33.5 m.; mean depth, 2.452 m.; mean velocity, 0.4419 m.; and



volume, 36.30 cub.m. The Laschin-darja had a breadth of 52.59 m.; mean depth, 1.805 m.; mean velocity, 0.5584 m.; and volume, 52.71 cub.m. in the second. Hence the total volume of the two amounted to 89.01 cub.m., or an increase of 1.8 cub.m.



over the measurement for the same conjoint streams on the day preceding. The transparency of the Kuntschekisch-tarim was 0.58 m., and of the Laschin-darja 0.43 m. while the temperatures of the two streams were 15.2° and 16.1° C. respectively. In

the rivers issuing from the lake we found the water ten times as clear: they leave their sedimentary matter in it, and this will in time fill it up. Proceeding upwards from the mouth of the Laschin-darja towards its source, the local topography bears the following names: Kemi-salik, Jantak-alghutsch, Irete-kojghan, Kutuk Begiköli, Tunglung-tschapghan, Arkalma, Dural (which is thus touched by an arm of the river), Kan-toghu (the Royal Dam, a name that points to some sort of administrative river-engineering in times past), and Ak-dung, the point already mentioned as that where the Laschin-darja breaks away from the Tarim and its kamisch lakes (see pp. 183—184).

Setting out from Säkitma we paddled farther on up the river. This continued very winding all day. Every now and again alluvial deposits and sand-banks projected above the surface, a proof that the level was at that time dropping. A peculiarly eccentric loop bears the name of Kumluk, although there is no sand visible. Laschin-kadaghan on the right bank is said formerly to have been a lake; there was there a boldschemal, then on the point of being abandoned, although it still possessed free communication with the river, indeed there was a current entering it and an island still remaining in the ring of the loop. At Matijas-söretmesi in the district of Kumluk we recognised again one of the camps of our February excursion (see p. 425). The embers and ashes of our camp-fire still remained, and I thus obtained a good and reliable point of connection with the map of my former journey. The name Haid Kullu-dung is given to a hill on which the man Haid Kullu once had his hut. Then for a space the river flows relatively straight towards the west. On the banks fields of kamisch alternate with magnificent toghrak forests; bush underwoods are less general, tamarisk-mounds are absent, sand occurs, in the shape of two or three rudimentary dunes, in one solitary spot. This tract, lying between the spreading river-arms, is fenced in as it were against the great sand. The people who now live at Mandschar-baschi used about ten years ago to dwell at the huts of Matijas-jatghan. During the course of the day we passed several shepherds' camps. One bek owned a flock of 1300 sheep, pastured at two different places. The shepherds spend the winter and spring beside this river, but it was about time for them to proceed to the Tarim. The district beside an extensive bend in the river is called Tömur Bekning-ghaghal-tasi. Upon reaching Modschuk-kotan we were once more in touch with the route of our former excursion.

On the 3rd May the scenery still continued monotonous, and the river preserved the same character as before, the only variation being that some bends were more sinuous than others. At the first bend there are on the north bank some small dunes and tamarisk-mounds, and at the second bend the river is joined by one of the arms of the Kontsche-darja, which issues at Jäkänlik. It was at that time dry, but is said to carry water in its upper reaches, that year being the first in which the water had failed to get down to the Kuntschekisch-tarim. After that point the south bank is called Jirim or Atschik-sudake-uj. The toghrak forest is here vigorous and of a good age. Tschapal, a place beside a tiresome bend, is now in ruins, though it was inhabited fifteen years ago. Then for a considerable distance the river maintains a straight course. Here is, on its north bank, the bushy region of Kirtschin-kotan, where I encamped in 1896. In the bed of the old desiccated lake of Attamet-



kölöghum amongst the poplars an attempt was made three years ago to grow wheat, and the Chinese have built a *gendeng*. Water was supplied by an arik, then dry, the mouth of which we saw; and yet another supply came through the Kumdan arm. In this way we arrived next at Ava Bismilning-kok-alasi, the lowest but one of the branches from the Kontsche-darja, which issues last out of some small reedy marshes close to the left bank of the river. There it forms three miniature waterfalls of 0.26, 0.36, and 0.73 m. descent. The arm had the following dimensions: breadth, 1.31 m.; mean depth, 0.22 m.; mean velocity, 0.70 m.; volume, 0.2 cub.m. in the second. Thus it was merely an insignificant rivulet, and yet it contributed something to the Kuntschekisch-tarim. The next arm of the Kontsche-darja was reached behind a fresh patch of sand; it bears the name of Judaktane-kok-alasi, and issues from a marsh full of kamisch. It forms a canal of uniform breadth, and in its lower part possesses traces of an old bridge. Higher up it passes through a little lake, in which it makes its descent down the step which corresponds to the miniature cataracts in the sister arm, and is no doubt of the same height as they are. At the point where we measured it, this arm was 6.10 m. broad, 1.305 m. in mean depth, and had a mean velocity of 0.1933 m., and a volume of 1.54 cub.m. in the second. Thus both arms put together carried merely 1.64 cub.m. of water.

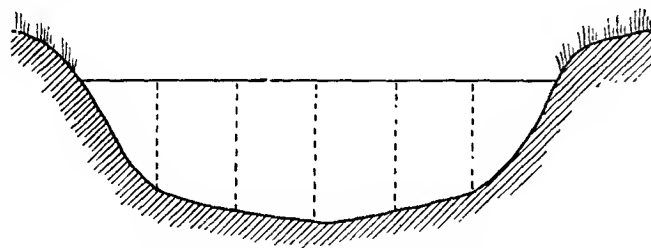


Fig. 438. 1.34 1.65 1.80 1.64 1.40 = depth.

19	20	23	23	23	} velocity.
20	15	19	23		

Breadth = 6.10 m. Judaktane-kok-alasi; May 3d. Scale = 1 : 100.

Then appeared one of the most eccentric loops I have ever seen, for the river came within an ace of cutting through the high, scarped banks which on both sides shut in the isthmus or »root» of the loop. Were it not for these lofty barriers one would not hesitate a moment about dragging the canoes across the narrow portage. Places of this kind are here called *kemi-söretma*, or »canoe dragging». At Schiadekidung on the south the great highway touches the river-bank. In a big loop that comes next, the river is joined by the Kumdan-darja, which, owing to its mouth being full of water, had the appearance of a large stream; but in reality it possesses no current, and its upper reaches are said to be even completely dry. This water-course is reported to have been called formerly Abdal, after a man of that name, but since the Chinese established here brick-kilns (*kumdan*) for supplying bricks to the new town of Dural, the river has been given its present name. The distribution of the water is said to be as follows. The water of the district of Ak-dung collects into the small lake of Gilang (the Naked, Open, i. e. free from reeds). At Tägirmän, on its right shore, the Chinese, at the instigation of the people of Dural,

built, eleven years ago, a *togh*, or »dam», with the view of forcing the water to go to Dural; in which project they were successful, and in this way the Kumdan-darja was originated. But in the autumn of 1896 the high flood burst the dam, and then the water proceeded without diminution into the Laschin-darja.

The district in which we were then is said to be called Lopu-nur by the Mongol pilgrims who go to Lassa.

On the 4th May we measured the volume in the Kuntschekisch-tarim, or, as it is also called in this district, the Ara-tarim. This was at Camp No. XLII, where the erosion terraces were 3.05 m. in height: the breadth was 43 m.; the mean depth, 1.426 m.; the mean velocity, 0.6314 m.; and the volume, 38.71 cub.m. in the second, or 2.4 cub. m. more than the volume at Säkirma on 2nd May. It is to be noted that the river, setting aside influx and efflux, increases in volume as one proceeds up it, or in other words diminishes in volume as it travels downwards, in consequence of evaporation, absorption into the ground, the drain of canals and marginal lakes, and other factors of that kind. But it likewise decreases upwards, because we were travelling *against* a stream which was at that season subsiding. As a consequence of this, peculiar fluctuations and oscillations are set up, and at a point a long way

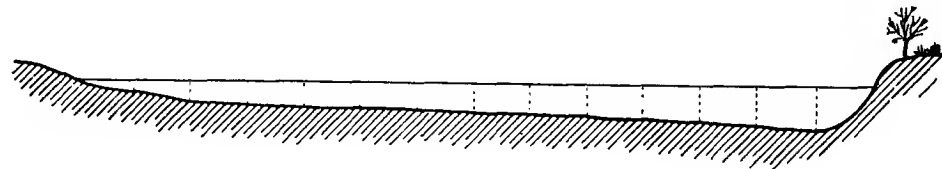


Fig. 439. Right. 0.42 1.06 1.22 1.30 1.35 1.41 1.62 1.78 1.72 1.81 1.90 2.02 2.35 = depth. Left.  
 23 50 67 70 72 78 79 78 81 81 85 79 58 }  
 40 50 61 71 72 66 78 80 78 83 72 68 } velocity.  
 49 61 61 62 72 68 69 71 67 57 }

Breadth = 43.0 m. Kuntschekisch- or Ara-tarim at Camp No. XLII; May 4th. Scale = 1 : 400.

down its course the river may thus have a bigger volume than it has higher up, whilst at the same time the effects of the fall and diminution are not yet propagated downwards to the points beyond which the high water has already passed. If one were to travel with the river day and night, one would find that the volume decreases pretty uniformly and regularly in consequence of evaporation and the other factors I have first mentioned. Also if at this season one were to investigate the volume at one and the same place during a given period of time, one would find that it decreases regularly, but then as a consequence of the setting in of the low-water season. If however one proceeds up-stream against the current, as we did, both these component factors come into play: the volume increases because we gradually approach localities in which the loss by evaporation is less, and the volume likewise diminishes because the stream naturally flows away downwards and because it is no longer fed by the same influx from above. The resultant of these operations would at this particular season be equivalent to  $\pm 0$ , or at all events, as in the last instance, we have an extremely slight difference.

During the day's journey toghraks were rare, and those we did see were young and ill-thriven. At Kargha-asti we have the beginning of the big and curiously formed loop of Dural; in two or three places it has cut its way through sand-bound soil.



*Ljustr. A. F. Lagrellius & Westphal.*

THE CONFLUENCE OF THE UGEN-DARJA AND THE TARIM, AT KARAU. VIEW LOOKING N.E.



Here an arik, though now dry, goes off to Dural, the grey square walls of which had long been in sight. But the place itself, with its huts and poor cabins, looks mean and poverty-stricken. The *amban*, or »Chinese governor», of Dural, by digging a canal, had attempted to drain the extremity of the loop and convert it into an orchard, but the attempt was not successful: the river refused to be turned out of its natural bed. A small canal issues also out of the adjacent little lake of Duralning-köli, which is fed from Ak-dung and Tägirmän; this was 5.6 m. broad, and had a mean depth of 0.43 m., and a volume of 0.17 cub.m. in the second. From the same source are likewise derived three ariks, of which two were however then dry, while the water in the last was stagnant. The first-named canal passes through the »town» itself, and is spanned by two bridges. The extremely small amount of water carried by these four canals from the Duralning-köli — which by the way appears to be identical with the lake of Gilang mentioned above — is a proof of the correctness of the information given to me, namely that the Kumdan-darja has dwindled at the expense of the Laschin-darja.

Then, turning back again to Kargha-asti, just mentioned, we passed our camp of the February expedition, and came to a canal issuing from the Kontsche-darja and called the Ägertschi-värghan-toj-bolghan-kok-alasi. This as well as the next following, Kasim-tschapghan, comes through the lake of Sap-kojdi. Both dry up during the summer, but a third emissary of the same lake, the Chodscha Kullu-tägirmän-kok-alasi, always carries water. This last divides into two arms, one of which was originally dug. Next follows the largest arm, the Turkomakte-kok-alasi, which I crossed in 1896 by means of a makeshift ferry-boat. Its channel had now a breadth of 12.2 m., a mean depth of 2.627 m., a mean velocity of 0.4495 m., and a volume of 14.40 cub. m. in the second. Then, after passing yet another difficult bend, we had on the right (i. e. the south) bank the beginning of the canal of Ak-katik-arik (see p. 428 above), which according to what I was told here has contained no water for many years. At that period the greater part of the Tarim is said to have travelled along the bed of the Kuntschekisch-tarim; the main channel to the west (the existing principal bed) only serving as an overflow conduit at the time of high flood. At the same date the majority of the population dwelt beside the Kuntschekisch-tarim, where, at several places, for instance at Tschapal, we saw their deserted huts. Another indication, that the river must formerly have been very much greater and more powerful than it is now, emerges from the fact that the bottom of the Katik-arik was 2.86 m. above the level of the river, and yet this

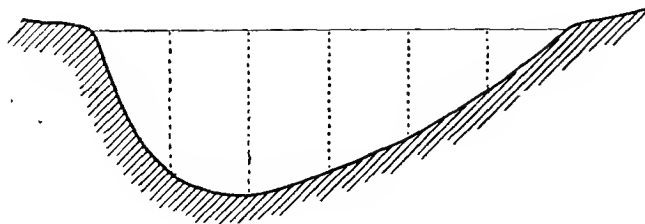


Fig. 440. Right. 3.60 4.20 3.65 2.82 1.49 = depth. Left.  
40 55 56 32 41 } velocity.  
48 55 58 48 28 }

Breadth = 12.2 m. Turkomakte-kok-alasi; May 4th. Scale = 1 : 200.

last was at that time pretty high. The containing banks were here 3 to 4 m. high and very distinctly marked. Thus, notwithstanding the diminution of volume, the bed still retained its character as the passage-way of a big river.

After a dry watercourse was passed, we came to the Koj-tutuni-kok-alasi, which likewise brings water from the Kontsche-darja. Then followed four other emis-saries from the same river, all irregular, winding streams which traverse numerous marshes and lakes. The first of these, the Tangsok-tägirmän-kok-alasi and the Tokta Chodscha-tägirmän-kok-alasi, both coming through the Süsük-köl, join the Kuntschekisch-tarim behind the old deserted village of Tikenlik, the huts of which (I sheltered in them in 1896) still stand uninjured on the bank. The other two, the Kirghuj Pavan-tägirmän-kok-alasi and the Ismail Achun-kok-alasi, drive mills.

Finally, turning our backs upon all these waterways, including eventually the Kuntschekisch-tarim itself (to the right or north), we penetrated up the Kalmak-ottogho, and having overcome its swift current arrived at the new Tikenlik. The lower part of this stream is crossed by two bridges.

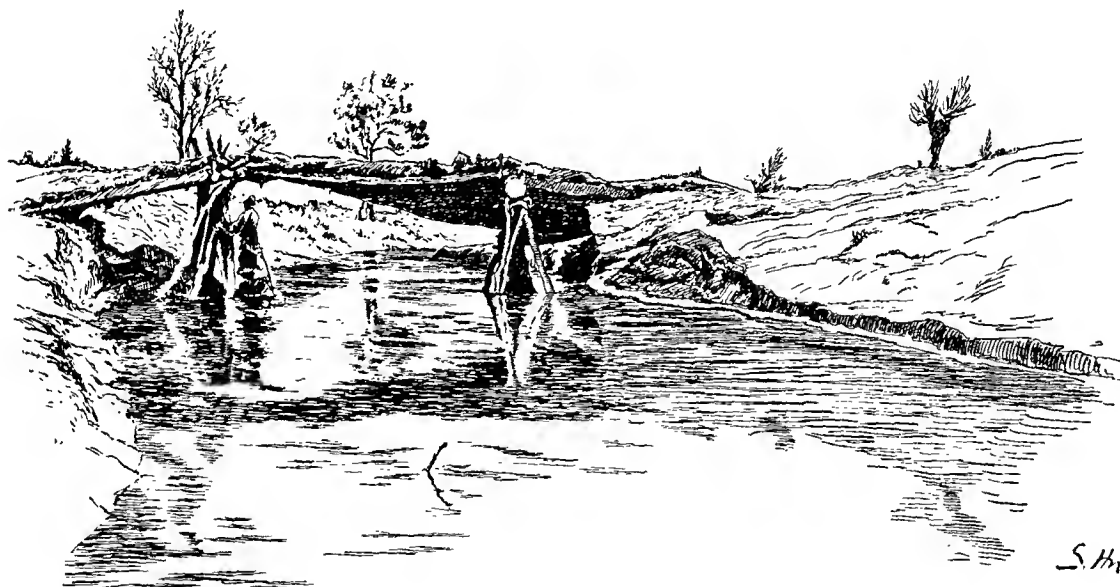


Fig. 441. BRIDGE OF KALMAK-OTTOGHO, NEAR NEW TIKENLIK.

All these arms of the Kontsche-darja put together carry a united volume of 17 cub.m. in the second, and of this amount 14.40 cub.m. alone belongs to the Turko-makte-kok-alasi. On the 5th May the Kuntschekisch-tarim gave the following dimensions above the confluence of the Kalmak-ottogho: — breadth, 30.7 m.; mean

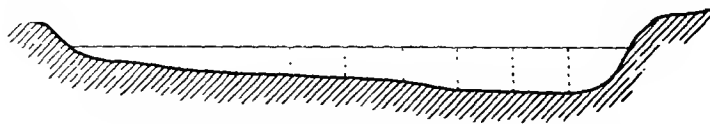


Fig. 442. Right. 0.78 1.19 1.42 1.53 1.71 1.80 2.26 2.32 2.35 = depth. Left.  
 40 42 48 50 56 61 60 52 27  
 29 29 38 40 40 61 48 49 27 } velocity.  
 37 29 37 50 37 40 33

Kuntschekisch-tarim above the confluence of Kalmak-ottogho; May 5th. Scale = 1 : 400.

depth, 1.538 m.; mean velocity, 0.3956 m.; and volume, 18.68 cub.m. in the second. On the same day the Kalmak-ottogho yielded the subjoined results: — breadth, 11.0 m.; mean depth, 0.500 m.; mean velocity, 0.3232 m.; and volume, 1.78 cub.m. in the second. Adding together these three amounts — 17.0, 18.68, and 1.78 cub.m. — we obtain a total 37.46 cub.m. for the united stream below the inflow of the Kontsche-darja arms, or rather less than the same river (the Kuntschekisch-tarim) yielded on the day before (namely 38.71 cub.m.). Hence, although we were travelling against the stream, there was an actual, though it is true a slight, diminution of volume.

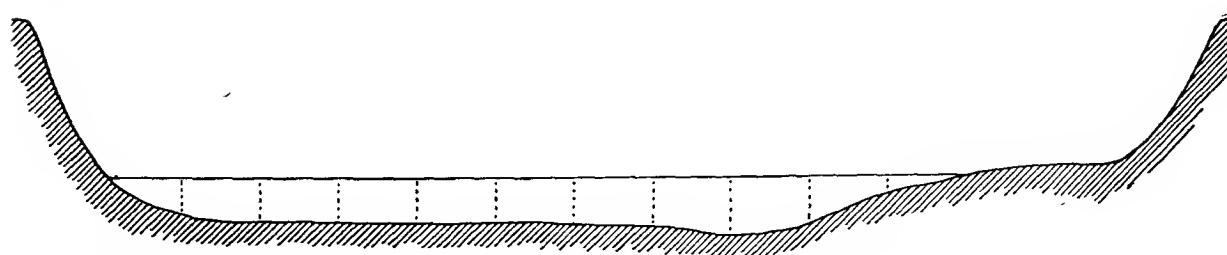


Fig. 443. 

0.48	0.53	0.57	0.56	0.56	0.58	0.65	0.75	0.63	0.19	= depth.
32	40	42	40	39	44	42	43	34	21	} velocity.
24	31	39	32	31	23	37	25			

  
 Breadth = 11.0 m. Kalmak-ottogho; May 5th. Scale = 1 : 100.

With regard to these Kontsche-darja arms, I was given in Tikenlik the following, and as it would seem trustworthy, information. The subjoined sketch, not quite clear I admit, of their mutual situations, was drawn for me by Naser Bek. As an actual fact all these lakes, which are now completely overgrown with reeds, must be looked upon as forming one big marsh, the only reason for the bestowal of various names\* being the occurrence at intervals of various patches of open water. Nevertheless the Kontsche-darja does discharge into it, and issues from it again divided into numerous arms: for instance, in the extreme east we have the Ilek or Bos-ilek, which drains into the Avullu-köl; then there are the ten arms or kok-alas I have just mentioned; and finally another stream of the same kind called Lanka, situated above the point where the Kuntschekisch-tarim is joined by the Kalmak-ottogho. The Lanka-kok-alasi is divided into two arms, and issues from a marsh in the im-

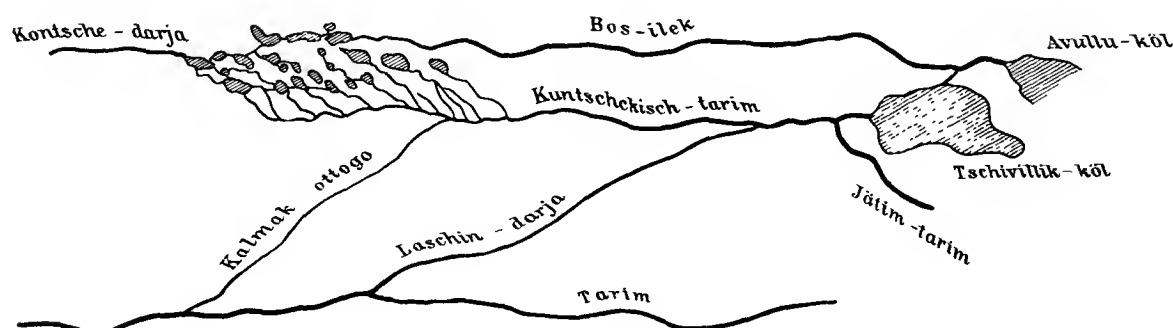


Fig. 444. ROUGH SKETCH OF THE CONFLUENCE OF THE KONTSCHE-DARJA AND THE TARIM.

\* Amongst these names are — Toghri-köl, Jokscho-köl, Tschapa-köl, Sadaki-dschajiri, Sapkojdi, Turkomak-köl, Bos-köl, Süsük-köl, Maltak-köl, Ansa Kullu-köl, and Tschulum-attam.

mediate vicinity; close to the river-bank its arms form a waterfall, with a single descent of 1.8 m. Above Lanka half a score or a dozen other kok-alas of varying size gradually unite to form the Ara-tarim or Kuntschekisch-tarim. The bed of this river becomes large and deeply trenched after receiving the Kalmak-ottogho, although this was at that time so insignificant; the greater part of the volume of the former is contributed, as we have seen, by the Turkomakte-kok-ala. Hence the amount of water contributed by the Kontsche-darja amounted to 48.90 cub.m., thus made up — the Bos-ilek, 13.22 cub.m.; the ten canals, 17.0 cub.m.; and the Kuntschekisch-tarim, 18.68 cub.m. In 1896 the Kontsche-darja at Korla gave a volume of 71.72 cub.m. in the second; so that in the intervening distance the river had lost 22.8 cub.m., the greater part of which had no doubt gone into the marshes. At this particular season of the year therefore the Kuntschekisch-tarim is fed principally by water from the Kontsche-darja. The streams from this last, which join the Kuntschekisch-tarim above the Kalmak-ottogho, contributed about the same amount as the streams below the same, namely 18.68 and 17.0 cub.m. respectively.

The following particulars as to the population of this region I owe to Naser Bek, bek of Tikenlik. His authority extended over 70 ujlik, thus distributed — 34 at Kirtschin, 14 at Ojman-köl, and 22 at Tikenlik, making a total of 500 to 550 persons. Jangi-köl is estimated to have 33 ujlik, half of them on the right and half of them on the left of the Tarim; and Tschara to have 23 ujlik. Both these *talluk*, or *tabesi*, were at the time of my visit subject to the authority of Baset Bek; while Tais-köl with its 37 ujlik was governed by Hassan Bek and Ibrahim Bek. Tschong-köl on the Intschkä-darja, which embraces 15 ujlik, is subject to Arsu Bek. The population of Kara-kum was put by Naser Bek at about 1,000 ujlik which is probably exaggerated, and of these 1,700 persons are Tunghans, 30 ujlik are Chordschas,\* and 200 Chinese, but none are Lopliks. The whole of the Lop region, from Laj-su (Al-katik-uj) as far as Kara-koschun, is considered to number 535 ujlik, amounting to about 9,025 individuals. Any statement of this kind emanating from a native must of course be accepted with great reserve; yet these estimates do not seem to me to be either exaggerated or improbable. Naser Bek stated that the boundaries of his administrative district pass through Chodai Vär-di-tschapghan (opposite Kuslek) on the Tarim, through Ova (*obo* = boundary-mark), midway between Dural and Tikenlik, and then to Beglik-köl, Talaschti-köl (on the Tarim), and Tschapghan-köl.

The following information, communicated by the same chief, is not without interest. Eighteen or twenty years ago, that is to say shortly after Jakub Bek's time, the Ara-tarim was dry about Old Tikenlik, and the Kontsche-darja flowed at that time through the Turkomakte-kok-ala, and then through its present bed, past Säkitma, and by way of the Jätim-tarim to Arghan. The Big Tarim kept at the same period to its most westerly channel close to the drift-sand. Since the water began to flow through the Kalmak-ottogho, the people had taken advantage of it to irrigate their fields at the present Tikenlik. Naser Bek calculated the dates of the older hydrography by the genealogy of his own family. Naser Bek himself was

\* This word is said to be of Chinese extraction, and signifies a settler who has flitted in from some other place. in the present case from Korla, Ak-su, and Turfan.



59 years old; his father Ishá Kasi had been 74; and *his* father, Mehemet Arsu Bek, 77. It was in the lifetime of the last-named that the people about Tikenlik first began to journey to Korla to buy flour, and bake themselves bread. Previous to that they had lived upon fish, the stalks and sprouts of *jäkän*, wild-duck caught in snares, and the eggs of both wild-duck and wild-geese. The father of Mehemet Arsu Bek was Kun Nias Bek, and he lived to between 70 and 80 years of age; his hut stood beside the Turkomak-köl, where the stream of Koj-tutuni begins. The father of Kun Nias was called Arsu Baj, and he both lived to about the same age and dwelt at the same spot, beside the same lake. In his days this lake is said to have been as bare of vegetation as most of the lakes in that locality are now; indeed the natives are said to have imported and planted *jäkän* (sedge) there. At the same epoch the westernmost bed of the Tarim did not exist; the river flowed through the present Kuntschekisch-tarim, though it would seem to have followed a different route, for the country around the existing Tikenlik was then desert, which indeed extended westwards right away to the big sand. Arsu Baj's father was Tschulum; he lived to between 70 and 80, and was the son of Säfär, who is said to have been the first Lop-man to have settled in this region. All these generations are stated to have dwelt beside the lakes of the Kontsche-darja, which during the course of time naturally underwent many changes and migrations. They knew nothing about agriculture or the keeping of live-stock, but lived entirely upon what they could procure from the water. The canoe was therefore their most important possession; they made their clothing, their nets, their ropes, and their cords for snares all of the fibres of plants. Since then however their mode of life has greatly changed, for they have become in no slight degree agriculturists, and sustain themselves also by breeding sheep. Then again, the easier communication between Tscharklik and Korla, and the periodical visits of the traders, have enlarged their demands upon life.

The road from Turfan to Dargh-ilek ran through Jigde-bulak in the Kuruk-tagh, and crossed the Ilek by a big bridge — probably the district I discovered in 1896, still called Turfan-köbruk. At that time the whole of the Tarim flowed past Dargh-ilek and through the Jätim-tarim. Indeed Naser Bek believed that the reason the Jätim-tarim was given the name it bears was precisely because it was subsequently abandoned, or as it were neglected.

These data however are neither sufficiently definite nor reliable to admit of precise determinations of date being deduced from them. The key to the calculation is in fact the answer to the question, how old was each of these men when his son was born? Assuming that they were each between 30 and 40 years of age, Säfär would have been born about 1640. In that case the changes which Naser Bek spoke of would be spread over a period of 250 years. The fact of the lakes having been for a certain period free from reeds would seem to indicate that they were then recent creations. Naser Bek's information agrees excellently well with what I was told by old Kuntschekan Bek of Abdal in 1896. What the country looked like before the 17th century cannot of course be satisfactorily inferred from local tradition. Consequently it is impossible from the local tradition to draw any conclusions as to the time when the great lake or marsh of Kara-koschun was for-

med. Beyond Säfär the roots of Naser Bek's genealogical tree cannot be followed. The natives themselves were disposed to trace the existing population of that part of the country of Lop, which is known to both Chinese and Mongols as Lop-nor, and the natural centre of which is Tikenlik, in contradistinction to Kara-koschun, which is the name of the southern Lop country — they were disposed to trace them back to two *atta*, or »ancestors», of the seventh degree, namely Säfär and Kujuk. Naser Bek and several other families in Tikenlik, Junus Bek and several others in Laj-su — have all sprung, together with yet others, from Säfär; while the people who dwell at Ullugh-köl, Jangi-köl, Ak-tarma, and various other places trace their descent from Kujuk. On the other hand, the present inhabitants of Tusun-tschapghan are said to bear a great resemblance, in their features, their dress, and their



Fig. 445. THE TRACES OF AN OLD DAM IN KALMAK-OTTOGHO.

manner of life, to Mongols. It cannot for one moment be doubted that the Lop people are a mixed race, showing both eastern and western affinities. Local tradition believes that the pretext which first brought Säfär to Tikenlik was the search for fresh fishing-grounds, the lakes beside which he had previously dwelt having dried up. The village of Lop near Chotan is said to have been founded by Lop-men from the neighbourhood of Tscharklik, who fled before an epidemic; it may be affirmed, with almost equal certainty, that the village of Lop near Kara-buran was likewise founded by colonists from the region of the old Lop-nor. The natives have a common apothegm — »Kirk jil ärne bakte, kirk jil järne bakte», meaning, »Forty years it travels, forty years it keeps its place»; that is to say, the river does not remain constant to one channel for longer than forty years at a time. This

throws a good deal of light upon the conception which they have formed regarding the instability of the hydrographical relations of the region in which they live. The preceding pages contain an abundance of instances of old river-beds, alluded to or described — more than sufficient in fact to justify the truth of the phrase in which the natives have embodied the results of their observation. Nevertheless the most pregnant and most striking example of the changeableness of these waterways still remains to be described.



Fig. 446. VIEW FROM THE LOWER PART OF KALMAK-OTTOGHO.

On the 6th May we continued our trip up the Kalmak-ottogho. Immediately above Tikenlik stand certain huts called Tikenlik-dschaji. Then we dragged our canoes over a small recently built dam, and across dry land until we came to the pretty large Säkis-kulatsch-toghi, or Eight Arms-lengths Dam, which was built fifteen years ago for the purpose of diverting the water of the Kalmak-ottogho to the fields of Tikenlik. Above this the waterway alters its appearance entirely: it is like paddling up a very broad river, except that there is no current, or next to none. This waterway, which winds precisely like a river-bed, is inclosed between old and dense forests of magnificent trees, and the higher we ascended the more beautiful as well as the more abundant they became. The banks are in part overgrown with reeds, in part free from vegetation. Here is the deserted village of Üntschüne-uji. In several places we observed traces of old huts, which were inhabited by Lopliks when the river flowed this way. Two deviations or bends which this waterway makes to the south touch not inconsiderable accumulations of sand. Eventually we turned out of this waterway into a narrow canal known as Muhamed Nias-osasidake-arik. It is in part artificially made, and in part it winds through the thick kamisch and jäkän, and soon terminates in some small lakes. At the north end of a narrow water-passage stands the village of Bobo Okuru-kadaghan, with the lake of the same name to the south of it. The village embraces 3 ujlik, of in all 17 persons, who spend the winter at Tikenlik. Close to the village are some little hills, commanding an extensive view of the kamisch-fields, marshes, small lakes,

and clumps of toghraks. To the north-east is the lake of Daschi-köl, and beyond it still more toghrak forest. After that we paddled along a small arm with a current in it, issuing from the lake of Tschorak-köl, on the shores of which there is a sprinkling of young toghraks. This brought us into touch with the Tarim, as we entered its northern arm, the Maseni-ilegi, with scattered toghraks and reeds on its banks, which eventually becomes lost amongst the lakes and marshes. At Kepek-uji the river divides; here we left on the south (our left) the branch which we were about to navigate with the big ferry-boat. From this point, Kepek-uji, to our headquarters at Jangi-köl the route coincided with that which we subsequently followed down the river, and which is described in the preceding pages. Just above Kepek-uji the velocity of the stream amounted to 1.22 m. in the second.

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This concludes my description of the river Tarim, and of all the watercourses that belong to its lower course, as well as the description of those parts of the western desert, the Takla-makan, which I visited during this journey. There are no doubt many streams and channels in this extremely intricate watery labyrinth which escaped my observation, so that my account of the Tarim, minute and detailed though it is, cannot claim to be absolutely exhaustive.

In the Second Volume of this work I shall proceed to describe the Karakoschun, and the relations which the Tarim has to this its terminal basin, and then deal with the Lop-nor and the desert regions to the east, the Desert of Lop and the western part of the Desert of Gobi.

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